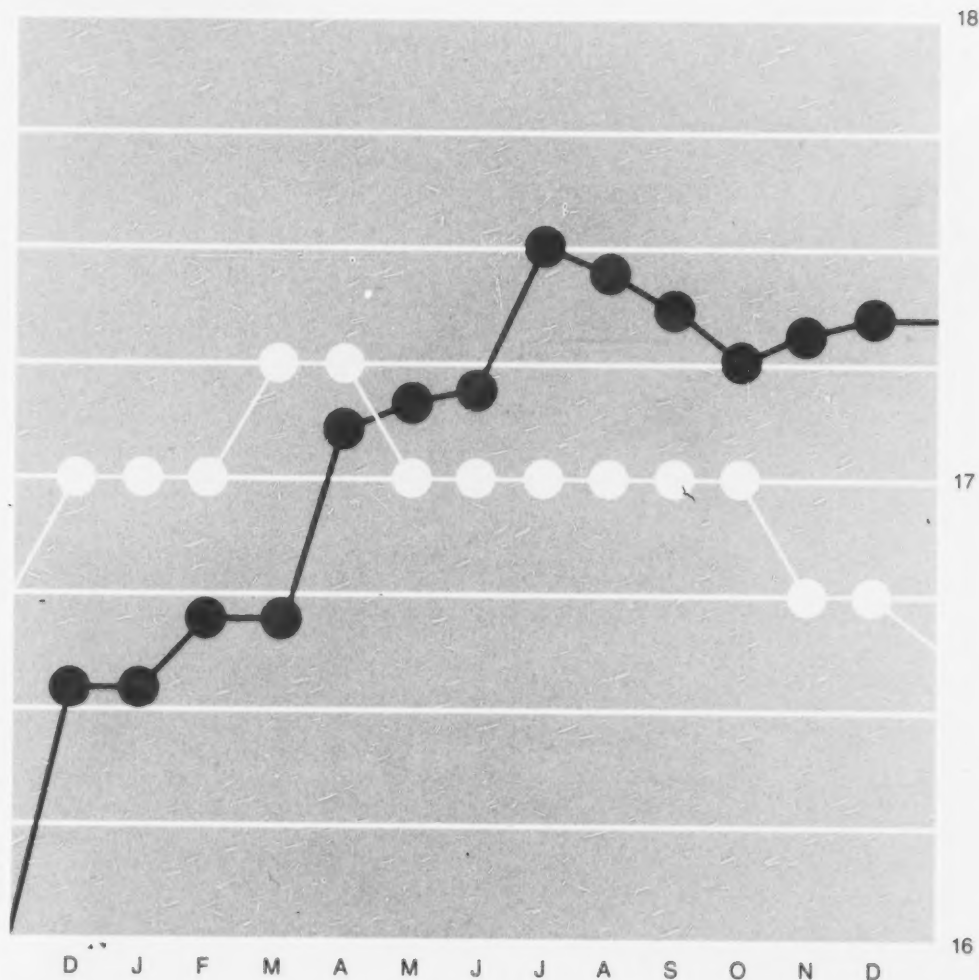




NUEXCO

Annual Review

1986





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URANIUM MARKET STUDY AND PRICE FORECAST

Nuexco is pleased to announce the immediate availability of our Uranium Market Study and Price Forecast. This report analyzes the international uranium market within a comprehensive methodological and judgmental framework, forecasting price trends during the period 1987-2000. Besides giving essential and timely business information, the Study is designed to guide customers in making vital business decisions affected by the current nuclear fuel price cycle.

This completely new edition of the Market Study examines the duration and magnitude of the price cycle, under both free market and restricted U.S. market conditions. The Study addresses in depth the following subjects under various scenarios:

- Consumption
- Production
- Inventory
- Unfilled Requirements and Uncommitted Supply
- Detailed Cost Estimates
- Price Forecast

In addition, the new report presents price forecasts both for spot prices and for base prices under new long-term contracts.

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1986 ANNUAL REVIEW

Special Report

March 1987

R. WESLEY MILLER, *EDITOR*

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To Our Readers

Nuexco is pleased to present the 1986 Annual Review to our full-service subscribers. As in the past, this Annual Review is the product of efforts from many Nuexco professionals. The editors appreciate the contributions and trust our subscribers will find the Annual Review informative and useful.

MARKET DEVELOPMENTS

NATURAL URANIUM SUPPLY, DEMAND AND PRICES

Overview

The US District Court decision directing DOE to impose protectionist measures in support of US producers was the most important uranium market development of 1986. If the current appeal affirms that decision, its effects will be felt for years to come. Its most dramatic effect would be the establishment of a two-tier market for US-origin and non-US-origin uranium. In that case, the decision could ultimately prove to be the most influential and far reaching market event since the 1979 Three Mile Island reactor accident. However, the District Court decision had no dramatic impact on prices during 1986.

Spot market prices for natural uranium were generally stable during the year, as indicated by Table 1. The trend of strengthening prices that had begun in the second half of 1985 stalled in early 1986. The Nuexco Exchange Value peaked at \$17.25 just before the June issuance of the US District Court decision. The resulting uncertainty about both the direction and degree of potential market segmentation led many buyers

and sellers to postpone marketing or procurement efforts until after a resolution of the DOE appeal. Those buyers and sellers that remained active focused primarily on meeting immediate needs or improving their capability to respond to the anticipated dislocations in the market. The main trends in the international uranium market may be summarized as follows:

1. Buyer sensitivity to uranium origin increased as a result of legal actions in the USA and political actions in North America and Europe. During the second half of 1986 in particular, differences in origin accounted for price differences of as much as a dollar per pound U_3O_8 , assuming equivalent delivery and payment terms.

2. The market for both *origin swaps* and *location swaps* (as opposed to sales) increased as a result of buyers' increased sensitivity to origin. Intermediaries played an important role in the expanding swap market and in other types of transactions.

3. The continuing decline of the US dollar against European currencies and the Japanese yen caused prices expressed in several non-US currencies to drop sharply (Table 2), thereby stimulating discretionary buyer interest in Europe

Table 1

1986 NATURAL URANIUM MARKET VALUES

Determined as of the Last Day of the Month	Published in Report Number	Exchange Value ¹ (per lb. U_3O_8)	UF ₆ Value ² (per kgU in UF ₆)	Conversion Value ³ (per lb. U in UF ₆)	Loan Rate ⁴ (per annum)
January	210	\$17.00	\$47.00	\$1.60	5%
February	211	\$17.00	\$48.00	\$1.80	5%
March	212	\$17.25	\$48.00	\$1.80	5%
April	213	\$17.25	\$48.50	\$1.90	5%
May	214	\$17.00	\$48.25	\$1.80	4%
June	215	\$17.00	\$48.25	\$1.80	4%
July	216	\$17.00	\$48.25	\$1.80	4%
August	217	\$17.00	\$48.00	\$1.90	4%
September	218	\$17.00	\$48.00	\$1.90	4%
October	219	\$17.00	\$48.00	\$1.90	4%
November	220	\$16.75	\$48.00	\$1.80	4%
December	221	\$16.75	\$47.75	\$1.80	4%
Annual Average		\$17.00	\$48.00	\$1.82	4.3%

¹The *Exchange Value* is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the dates indicated.

²The *UF₆ Value* is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of natural uranium hexafluoride could be concluded as of the date indicated.

³The *Conversion Value* is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the dates indicated.

⁴The *Loan Rate* is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the dates indicated.

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and decreasing the competitiveness of European sellers forced to offer at US dollar prices.

4. Inventory liquidation by utilities and other entities, which had been a dominant feature of the uranium market in the first half of the 1980s, played little part in the market during 1986.

5. In the longer-term market for uranium concentrates, buyer interest focused on US producers, who expected that a favorable resolution of the producers' lawsuit could stimulate production under a protectionist environment. In addition, Australian producers, intent on increasing their production and competitiveness, aggressively pursued marketing opportunities.

Influence of Origin on Price

During 1986 the practice of specifying the national origin of material being sought and offered became more prevalent in the international market than it had been in previous years. Uranium from each particular country of origin is affected by variations in commercial desirability based on several factors:

1. Political acceptability;
2. Restrictions imposed on the material's end use;

3. Possible embargo-related limitations;

4. Limitations imposed on form required for export.

In general, the events affecting US-origin and southern African-origin uranium sensitized participants in the international market to these factors. The following paragraphs discuss the commercial acceptability of certain uranium origins to various buyer nations.

United States: Because of the generally perceived likelihood that some degree of protectionism will force US utilities to enrich or use US-origin uranium in preference to other origins (to a degree as yet undetermined), US-origin commands a small premium in the USA. Conversely, many non-US utilities, particularly those that convert and enrich outside the USA, have no reason to prefer US-origin and may even discount it because of the US insistence on granting prior consent in each case, rather than generically, before allowing reprocessing. Potential buyers of US-origin uranium (which includes, but is not limited to, output from US production centers) are almost entirely domestic.

The single most important event affecting uranium prices during 1986 was the court order issued June 20 by Federal District Court Judge Jim Carrigan in Denver, Colorado, in response to a lawsuit brought by a group of US producers

Table 2
NUEXCO EXCHANGE VALUE AT QUARTERLY INTERVALS DURING 1986
EXPRESSED IN SELECTED CURRENCIES

Country (currency)	December 31, 1985	March 31, 1986	June 30, 1986	September 30, 1986	December 31, 1986	Percent Change Since 12/31/85
Australia (dollar)	24.92	24.20	25.35	27.06	25.21	+ 1
Belgium (comm. franc)	854.70	823.00	765.08	714.29	678.06	- 21
Canada (dollar)	23.78	24.09	23.60	23.58	23.16	- 26
EEC (ecu ¹)	19.16	18.41	17.52	16.50	15.73	- 18
Finland (markka)	92.19	89.33	87.13	83.37	80.65	- 13
France (franc)	128.40	123.66	119.30	112.29	108.00	- 16
FRG (mark)	41.87	40.19	37.43	34.32	32.58	- 22
Italy (lira)	28,509	26,038	25,703	23,800	22,681	- 20
Japan (yen)	3,413	3,098	2,810	2,608	2,677	- 22
Netherlands (guilder)	47.16	45.53	42.12	38.90	36.85	- 22
South Africa (rand)	43.87	35.75	42.29	37.53	36.81	- 16
Spain (peseta)	2,621	2,510	2,399	2,269	2,219	- 15
Sweden (krona)	128.98	126.65	121.26	117.48	114.10	- 12
Switzerland (franc)	35.31	33.56	30.63	27.81	27.22	- 23
UK (pound)	11.82	11.68	11.10	11.85	11.40	- 4
US (dollar)	17.00	17.25	17.00	17.00	16.75	- 1

¹Nuexco began reporting the Exchange Value in ECUs in December 1986.

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against the US Department of Energy (DOE). The court ordered DOE, the principal supplier of enrichment services to US utilities, immediately to restrict its enrichment of source or special nuclear materials of non-US origin intended for use in a US reactor. The restriction called for enrichment of no more than 25 percent of such material between June 6, 1986 and December 31, 1986, and none after January 1, 1987, until the viability of the domestic uranium production industry is assured. Although Judge Carrigan's order was stayed in July pending the outcome of DOE's appeal to the Tenth Circuit Court of Appeals, it marked a preliminary victory by the US producers. The judgment also marked the beginning of a divergence of prices for US-origin material and uranium of other origins. (See the *UNITED STATES* section of this Report for an account of the UPA-DOE lawsuit, the Carrigan order, and the subsequent events.)

Because the order was stayed pending appeal and the appellate court's decision had not been issued by the early part of 1987, DOE was not forced to comply with the order during 1986 and US utilities were *not* required to supply any minimum percentage of US-origin uranium for enrichment at DOE. Nevertheless, uncertainty about the timing and substance of the Tenth Circuit Court's decision caused some utilities to take preemptive action in the event the Carrigan order is upheld. Each utility has a unique uranium supply situation; a minority of US utilities have 100-percent US-origin in stock and under contract, and many US utilities have less than half of their total supply as US-origin. During the second half of the year, several US utilities took action to preserve their existing stocks of US-origin uranium, or to procure additional US-origin either by direct purchase or through swap agreements. As a result, the market value of US-origin uranium exceeded that for uranium of other origins. Late in the year, Nuexco began publishing specific numerical values for the premium associated with US-origin uranium. In December 1986, US-origin concentrates commanded a premium (relative to the Exchange Value) of \$0.75 per pound U_3O_8 . Similarly, US-origin UF_6 commanded a premium of \$2.50 per kgU in December.

A second event in the USA which increased the commercial importance of uranium origin occurred in September and October 1986, when the US Congress overrode President Reagan's veto and enacted economic sanctions against the Republic of South Africa and Namibia. Included among the terms of the law is a ban on the US importation of southern African uranium. The law took effect on January 1, 1987. As of that date, southern African producers had stockpiled enough uranium within the USA to meet contractual commitments for North American deliveries for the near future. Two important questions remained to be answered regarding the

enforcement of the law: whether it would apply to southern African uranium imported as UF_6 and fabricated fuel, and whether it would prevent transient imports of southern African uranium, i.e. temporary importation and reexport for eventual use by non-US companies. In March 1987, the Treasury Department published a final rule that provides essentially that UF_6 is not covered by the sanctions against importation. Regardless of the outcomes of these issues, the law clearly establishes a national policy under which US utilities are encouraged to refrain from using uranium of southern African origin. Most US utilities have avoided such uranium for many years simply to minimize controversy within their service areas and with their regulators, but the public nature of the sanctions bill has virtually eliminated any possibility of new sales of southern African-origin uranium to US utilities.

Europe: Sensitivity to southern African uranium during 1986 was not confined to the US market; several European companies and governments expressed discomfort over purchasing uranium of southern African-origin. In addition to the *de jure* embargo on imports into the USA, Swedish, Dutch, and British utilities all enforced existing *de facto* policies against the procurement of southern African uranium. A French sanctions bill imposed in 1985 prevented Electricite de France (EdF) from signing any new contracts with southern African producers during 1986. The local government of Hamburg, located in the northern part of the Federal Republic of Germany, prohibited Hamburgisches Elektrizitaetswerke AG (HEW) from procuring southern African uranium. However, most European governments hesitated to enact legislation prohibiting the use of southern African uranium because of their countries' lack of indigenous uranium resources and because of policies favoring supply diversity. The dependence on southern African-origin uranium will also remain significant in Japan and Taiwan, where the respective governments have taken no action against current commitments to southern African deliveries.

Canada and Australia: With few exceptions, both the Canadian and Australian governments prohibit the use of uranium produced in their countries by political entities that have not signed the Nuclear Non-Proliferation Treaty (NPT). Both countries also require that uranium subject to their safeguards and provisions not be left in the USSR. As a result, the market for these origins is limited to signatories of the NPT or special bilateral agreements. Companies having enrichment contracts with Techsnabexport (TSE) of the Soviet Union may find it desirable to diversify away from these origins since the companies are otherwise bound to

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remove depleted uranium, along with enriched product, from TSE, thus increasing the effective cost of enriching uranium in the USSR.

Niger and Gabon: No political barriers restrict the use of central African-origin uranium, so the market for it is worldwide.

South Africa and Namibia: *De jure* sanctions imposed by the USA and *de facto* sanctions of many European governments limit the current market for material of southern African-origin. However, because the South African and Namibian governments do not impose prior consent restrictions on the use of southern African-origin material, and because South Africa and Namibia have been reliable, long-term suppliers to many nations, there remains substantial international demand for uranium of southern African-origin.

China: Chinese-origin uranium may be used in countries having bilateral agreements with China, such as the USA, France, Germany and the USSR. China has several other bilateral agreements in negotiation.

Other: With the exception of Portuguese-origin uranium, which is not known to carry any political constraints, most other origins such as French, Spanish, Argentine and Brazilian are essentially 100-percent captive to national programs.

The Role of Intermediaries

The increasing imperfections in the market caused the role of intermediaries to increase during 1986. Brokers and trading companies facilitated complex transactions in order to fulfill the specific needs of buyers, particularly with regard to material origin, form and delivery location. At times during 1986, when the most competitive sellers were Canadian or southern African producers, intermediaries arranged *origin swaps* to enable the non-US sellers to satisfy the buyers' near-term demand for US-origin. Many transactions required transoceanic *location swaps* as well as changes in origin.

Intermediaries also facilitated other types of transactions, such as financed transactions in which traders arranged back-to-back purchase and sales agreements that met the primary parties' differing requirements with respect to delivery location, delivery schedule, as well as time and currency of payment. As in past years, intermediaries also facilitated sales of enriched uranium product by arranging the resale of contained SWU, conversion and concentrates to several buyers. The complexity of many market transactions increased substantially during 1986 with the implementation of these and other techniques. In addition, because of the role of intermediaries, the year's total transaction volume, includ-

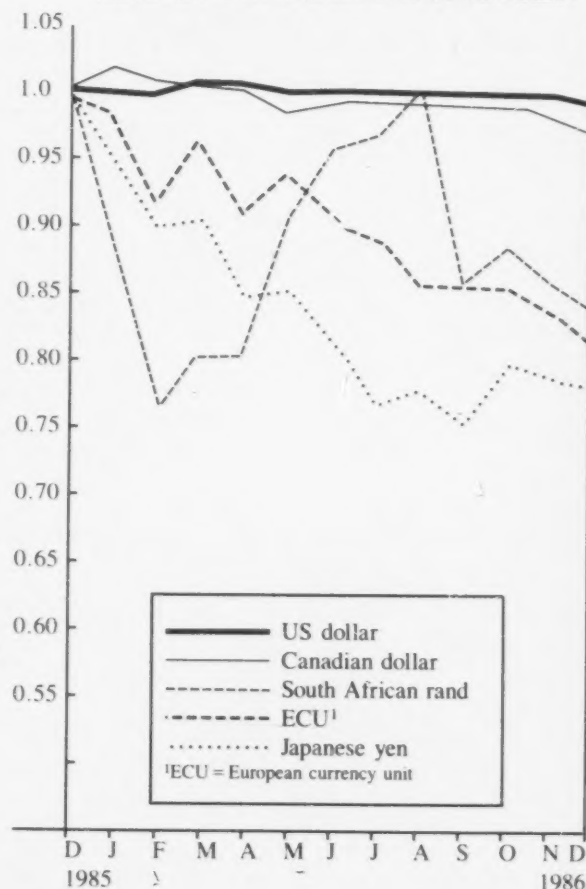
ing sales to all parties, greatly exceeded the volume of sales to end-users.

The Decline of Prices in European Currencies

Continuing a trend that began in early 1985, the US dollar declined steadily against the Japanese yen and key European currencies during 1986. At the end of the year the dollar had reached its lowest level against the yen in the postwar period and its lowest level against key European currencies in almost a decade. Consequently, while the Exchange Value declined 1.5 percent between December 31, 1985 and December 31, 1986, as expressed in US dollars (Figure 1), the difference as expressed in German marks was a decline of 22.2 percent.

Figure 1

RATIO OF 1986 EXCHANGE VALUES TO
EXCHANGE VALUE OF DECEMBER 31, 1985
MEASURED IN SELECTED CURRENCIES.



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Table 2 shows the Nuexco Exchange Values on a quarterly basis during 1986 expressed in selected currencies. Table 3 shows the exchange rates used to derive the annual percentage change.

Given the already low level of uranium prices by historical standards, the weakness of the dollar translated into exceptionally attractive prices for many non-US buyers, particularly toward the end of the year. Some European utilities, while not actually in need of material to fill immediate requirements, entered the market toward the end of the year to take advantage of the highly favorable currency situation.

How long the dollar will remain weak is a matter of speculative interest in all fields of international trade, including the uranium market. By early 1987, there was some evidence to support the belief that the dollar had reached its lowest point, mainly due to public expressions by finance ministers, a boom in US investment markets, and preliminary figures indicating a recent improvement in the US trade balance. The extent of any recovery by the dollar will probably depend on the actual improvement of the trade balance; near the end of 1986 that balance showed a record deficit.

Decline of Secondary Market Distress Selling

During the early 1980s, much of the selling activity driving the spot market for uranium had been initiated by companies forced to liquidate their uranium stocks. In the case of utility sellers, the cancellation of nuclear plants on order or under construction forced such sales. In the case of producers and other entities, management decisions to withdraw from the uranium business required liquidation of inventory. During 1986, however, only one utility liquidated its total uranium inventory in the spot market, and fewer producers and other entities conducted forced sales. In part, these actions account for the market's resistance to any significant price decrease.

Conversely, prices did not rise during 1986 primarily because utility demand remained thin and producer supply remained more than adequate (Table 4). Utility demand worldwide has been weak in recent years because of large inventories and adequate long-term supply coverage. However, because uranium production had exceeded the annual needs of utilities in every year through 1984, large inventories have been built up by many producers; thus, that

Table 3
YEAR-END EXCHANGE RATES¹
(Currency per US dollar)

Country (currency)	As of Dec. 31, 1985	As of Dec. 31, 1986	Percent Change
Australia (dollar)	1.47	1.51	+ 4
Belgium (comm. franc)	50.28	40.48	- 20
Canada (dollar)	1.40	1.38	- 1
EEC (ecu)	1.13	0.94	- 17
Finland (markka)	5.42	4.82	- 11
France (franc)	7.55	6.45	- 15
FRG (mark)	2.46	1.95	- 21
Italy (lira)	1,677	1,354	- 19
Japan (yen)	200.75	159.85	- 20
Netherlands (guilder)	2.77	2.20	- 21
South Africa (rand)	2.58	2.20	- 15
Spain (peseta)	154.20	132.45	- 14
Sweden (krona)	7.59	6.81	- 10
Switzerland (franc)	2.08	1.63	- 22
UK (pound)	0.70	0.68	- 3
US (dollar)	1.00	1.00	0

¹Currency exchange rates from the *Wall Street Journal* of the date indicated.

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Table 4
1986 SPOT AND NEAR-TERM¹ SUPPLY AND DEMAND FOR NATURAL URANIUM
(Active² inquiries as reported by Nuexco)

Determined as of the Last Day of the Month	Report Number	Uranium Supply ³ (Available for Sale)	Uranium Demand ³ (Inquiries to Purchase)	Spot and Near- Term Supply/ Demand Ratio	Exchange Value (per lb. U ₃ O ₈)
January	210	3.9	2.8	1.4	\$17.00
February	211	2.4	1.0	2.5	\$17.00
March	212	2.5	1.0	2.7	\$17.25
April	213	2.6	1.2	2.1	\$17.25
May	214	4.2	1.0	4.3	\$17.00
June	215	4.1	2.1	2.0	\$17.00
July	216	3.9	2.7	1.4	\$17.00
August	217	4.2	1.5	2.9	\$17.00
September	218	4.1	1.4	2.9	\$17.00
October	219	3.7	1.0	3.9	\$17.00
November	220	4.5	0.8	5.9	\$16.75
December	221	4.1	0.8	5.2	\$16.75
Annual Average		3.7	1.4	3.1	\$17.00

¹ For delivery within one year.

² Involving competitive price, terms, and other conditions.

³ Millions of pounds U₃O₈ equivalent.

component of supply still acts to hold down price increases in the spot market. The overall balance between thin demand and excess supply precluded a significant price rise during 1986.

Supply and Demand

The desire by some US utilities to increase the percentage of US-origin material in inventory contributed to an increased demand for that origin uranium. Prompted by the availability of a premium for US-origin, non-US utilities, traders and other entities combined their efforts to increase the available supplies of US-origin material. At the same time, US producers essentially withdrew from the spot market, generally offering their material at prices several dollars above prevailing spot market levels. Other than a few sales near Exchange Value, US producers did little direct spot selling, even though ample supply was available. By the end of the year, supplies of US-origin material available through swaps had decreased and asking prices for swaps had increased. At the same time, however, demand did not increase dramatically as buyers of US-origin material waited for a resolution of the court case.

As demand for US-origin uranium grew, a two-tiered market began to emerge. However, whether the premium for US-origin would be highly transitory or relatively long lived depended on the outcome of the court case. Because that outcome remained uncertain, the demand for US-origin, which caused the premium, resulted from a perception in the market rather than a legal or political reality. At first, what later came to be regarded as the premium was merely the swap fee involved in procuring US-origin material through swap transactions. Because US producers insisted on prices considerably above the Exchange Value level, their asking prices did not reflect the true premium. As the year progressed, the cost of obtaining US-origin material increased. Increasing demand for US-origin could cause the premium to climb to much higher levels if effective restrictions on US imports of non-US-origin material are enacted.

As the year progressed, Canadian producers aggressively pursued sales opportunities. While prices of Canadian U₃O₈ remained fairly steady, flexibility in terms and conditions enabled some transactions to be completed. Australian producers, who otherwise might have increased available supply, effectively were constrained by the Australian government

MARKET DEVELOPMENTS

floor price. For the first time, Chinese uranium was available on the spot market. Its effect on the spot market supply was not great, both because asking prices were rather high and because the Chinese showed a clear preference for long-term contracts.

Outside the USA, demand for uranium without restrictions on end use remained firm.

1. Such uranium is desirable in Europe because of the increasing importance to European utilities of recycling uranium and plutonium.

2. When using Soviet enrichment services, western customers generally prefer to use uranium without end-use restrictions rather than remove the depleted uranium from the USSR.

Transaction Analysis

During the twelve months from January 1986 through December 1986, (Reports 210-221, February 1986 to January 1987) Nuexco reported 56 transactions for the sale of uranium contained in U_3O_8 concentrates, natural UF_6 and enriched UF_6 , involving a total of 11.1 million pounds U_3O_8 equivalent, for spot and near-term delivery (Table 5).

As in past years, Nuexco's reporting of nuclear fuel transactions is subject to some limitations. Certain transactions may not have been reported because of one or more of the following circumstances.

1. Nuexco chooses not to report transactions (or certain information about published transactions) if the reporting of such information would jeopardize client confidentiality.

2. Transactions about which insufficient reliable information could be ascertained are not reported.

3. Because of the subjective nature of Nuexco's judgments, some agreements between parties may be reported as transactions only to collapse later during final negotiations. An agreement may be judged a transaction as soon as the parties verbally agree, as late as contract signing, or even later, depending on Nuexco's confidence that the agreement will be concluded. In addition, different market observers, even if given identical information, can reach different conclusions on the question of when a negotiation becomes a transaction that merits reporting.

4. Delivery of material under old contracts, new deliveries, or the exercise of options for additional material under old contracts are not regarded as new transactions. Similarly, renegotiations of old contracts are not included as new transactions.

5. The analysis of 1986 transactions did not include those which took place in 1985, but were reported in early 1986. It did not include transactions involving material other than U_3O_8 , natural UF_6 , or low-enriched uranium.

Table 5
TRANSACTIONS: SPOT OR
NEAR-TERM URANIUM SALES¹
REPORTED BY NUEXCO IN 1986
(Millions of pounds U_3O_8 equivalent)

SELLERS	BUYERS			
	Utilities	Other Entities	Prod.	Total
Producers	5.87	1.56	0.18	7.61
Other Entities	1.86	0.05	0.00	1.91
Utilities	0.74	0.08	0.75	1.57
Total	8.47	1.69	0.93	11.09

¹Does not include transactions which fall into one or more of the following categories:

- Transactions which took place in 1985 but were reported in 1986;
- Transactions which involved fabricated fuel;
- Transactions that Nuexco was aware of but chose not to report, either to protect client confidentiality or because Nuexco was not satisfied with the reliability of our information, and/or
- A negotiation which has not advanced to such a degree that Nuexco would judge it a completed transaction. Because of the subjective nature of Nuexco judgments, some pending negotiations may have been reported as transactions only to fail through later. In these cases, the transaction was omitted from this table.
- Finally, a transaction is not a delivery of material, and options or new deliveries from old transactions are not regarded as transactions.

In cases of back-to-back sales, although two sales contracts are involved, Nuexco averages the price and reports only one transaction. However, Nuexco may report both sales and purchases involving trading activities, depending on Nuexco's knowledge of the transactions. In certain cases, transactions reported for a given month actually may not be completed for some time after publication due to unexpected delays in the progress of negotiations.

Table 5 aggregates the reported transactions by seller groups and buyer groups. Of the 56 uranium sales transactions reported in 1986, 27 involved natural UF_6 , 25 involved U_3O_8 , and four involved low-enriched uranium. In terms of pounds of material delivered (or to be delivered), approximately 5.7 million pounds U_3O_8 equivalent (51 percent) was in the form of natural UF_6 , and 4.7 million pounds (42 percent) consisted of concentrates.

Table 6 sets forth the form of the uranium purchased in those transactions reported by Nuexco, the quantity which

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was US-origin, and the amount of material purchased for which the sales were facilitated by origin swaps. That natural UF_6 accounted for the bulk of material sold was mainly due to utility preferences for UF_6 , the conversion component of which is less costly than primary conversion. Supplies of UF_6 came from Canadian producers, who are constrained somewhat to export UF_6 due to the upgrading requirements of the Canadian government, and from intermediaries able to convert concentrates in the secondary market before sale to end-users. Low-enriched uranium accounted for slightly over 760,000 pounds U_3O_8 equivalent (7 percent).

Table 6
FORM AND ORIGIN OF MATERIAL
PURCHASED IN 1986
SPOT AND NEAR-TERM TRANSACTIONS
REPORTED BY NUEXCO

Transaction Subgroup	Millions of pounds U_3O_8 equivalent	Percent of Total Quantity
U_3O_8 Concentrates	4.68	42
Natural UF_6	5.65	51
Enriched UF_6	0.76	7
TOTAL	11.09	100
US-Origin ¹	5.63	51
Facilitated by Origin Swap ²	4.33	39

¹Nuexco estimate.

²Although most sales involving origin swaps facilitated purchases of US-origin, this category also includes purchases of other origins facilitated by swaps.

Nuexco estimates that half of all the material purchased carried a US-origin label, resulting from the preference of many US utilities. Nevertheless, many European utilities and some US utilities purchased Canadian-origin uranium, and substantial sales of other origins also occurred in Europe.

The great majority of buyers in 1986 transactions were utilities, both in number of transactions and in total volume of material (Figure 2). Sales from producers to utilities comprised the single largest transaction category, accounting for approximately 53 percent of all material purchased. Of those sales, approximately one-third involved US-origin of all categories, of which about 60 percent was UF_6 and about 40 percent was in the form of U_3O_8 . The other two-thirds was

about equally split between non-US origin U_3O_8 and UF_6 . In addition, utilities bought another 17 percent of the total amount from traders and other entities. Slightly less than seven percent of the total was sold by utilities to utilities, all in the form of low-enriched uranium. In all, utilities purchased over three-fourths of the uranium purchased in 1986.

Producers sold nearly 70 percent of the total volume of material in 1986 (Figure 2). In this category, Canadian producers were the dominant sellers, although US producers also completed a substantial sales volume, particularly in the first half of 1986. In contrast to 1985, in which producers bought over 2 million pounds of uranium on the spot market, in 1986 purchases by producers in the USA declined substantially, to less than one million pounds. The high-cost producers that in past years had bought on the spot market to fulfill contracts rather than produce from their own operations had essentially completed that phase of their operations.

After the issuance of the Carrigan order, US producers generally withdrew from the market, anticipating a dramatic improvement in prices for their material. African producers completed sales in the spot market for substantial quantities, but primarily through the use of intermediaries, so their sales were not included in the producer category. Other producers concluded some sales in the spot market, including the China Nuclear Energy Industry Corporation (CNEIC) which made its first spot sale of PRC uranium to a western entity.

Traders and other entities purchased approximately 1.6 million pounds U_3O_8 equivalent from producers during 1986 and in turn sold about 1.9 million pounds to utilities. The amount sold in this category has declined from 3.8 million pounds in 1984, and 2.3 million pounds in 1985. Sales by traders in 1986 may have exceeded their purchases because of trader inventories at the start of the year or because of undocumented purchases. Much of the sales activity of traders involved complex transaction mechanisms.

Sales by utilities totaled approximately 1.6 million pounds equivalent U_3O_8 , of which slightly less than half was in the form of low-enriched uranium. In contrast to 1985, less than five percent of the material sold by utilities was in the form of natural UF_6 . However, over 85 percent of the total sold by utilities in 1986 came from one large sale of U_3O_8 and a large sale of low-enriched material.

Nuexco estimates that origin swaps facilitated approximately 39 percent of the purchases reported. Table 7 lists data accumulated by Nuexco during 1986 pertaining to the origin swap market. The importance of material origin led a number of market participants, including producers, intermediaries and utilities, to seek origin swaps, particularly in the second half of the year. The desire to increase the market

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value of their uranium and to mitigate the possible effects of a likely US origin restriction motivated some non-US producers to purchase US-origin through swaps. Some utilities bought through swaps in order to diversify the origins of their inventories. In this respect, US utilities actively engaged in internal swapping of their own stocks. The technique sometimes involved exchanges of origin between US-origin material contained in enriched uranium (or even fabricated fuel) and non-US-origin contained in natural uranium. (Such internal swaps are not included in Table 7.) In the spot market, intermediaries furnished the primary impetus in the commercial swap market by using swaps to link offers for one origin with requests for another origin. Swap prices in 1986 generally varied (depending on origin and timing) within a range of zero to \$0.75 per pound U₃O₈ equivalent.

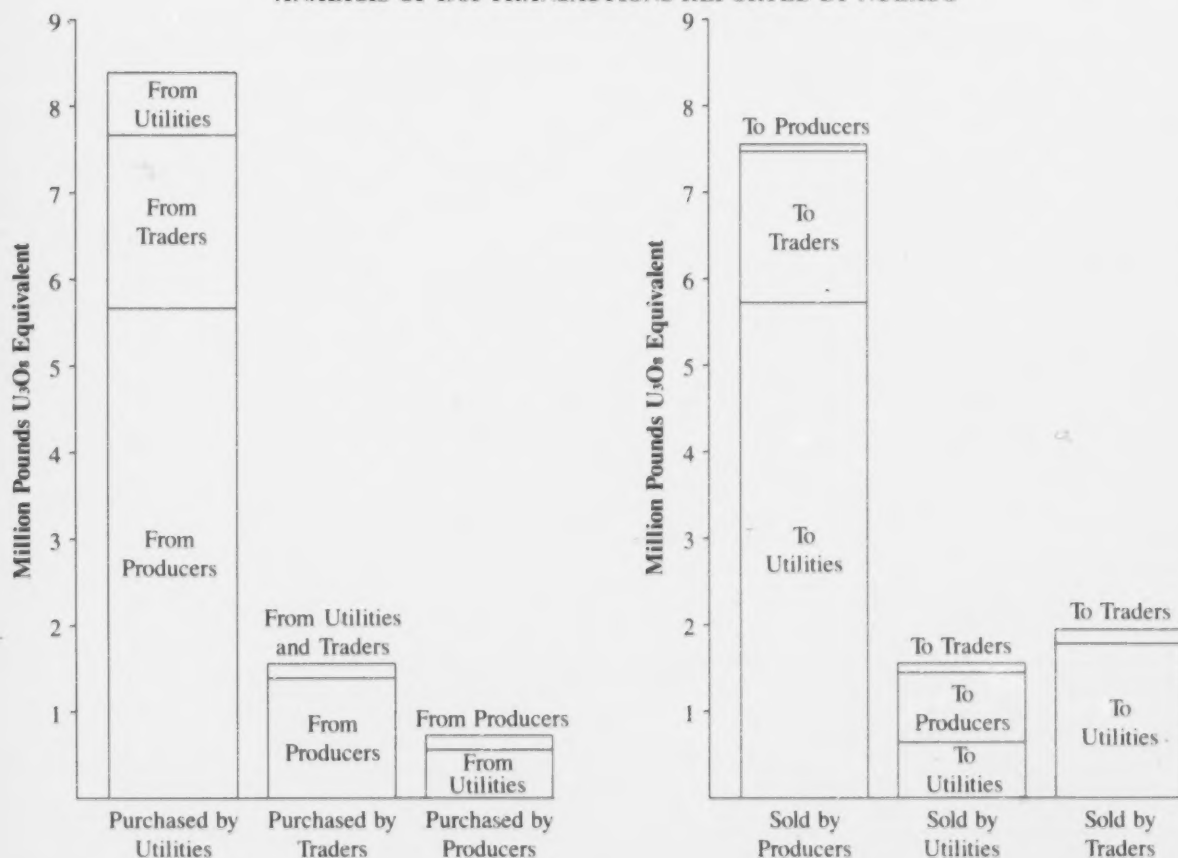
Table 7
1986 ORIGIN SWAP TRANSACTIONS¹

Transaction Subgroup	Number of Transactions	Millions of pounds U ₃ O ₈ equivalent
US for Non-US	16	5.54
Non-US for Non-US	5	1.97
TOTAL	21	7.51

¹Nuexco estimates of transactions involving at least two parties. Data recorded for internal use by Nuexco may not include all swap transactions. Includes both origin swaps used to facilitate sales and swaps made for other strategic reasons. Swaps may involve location exchange as well as origin.

Figure 2

ANALYSIS OF 1986 TRANSACTIONS REPORTED BY NUEXCO



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Transaction Value

The Transaction Value (TV) published monthly by Nuexco is a weighted average of prices paid for natural uranium in spot and near-term transactions of at least three immediately preceding months. The conditions for the calculation stipulate that at least ten transactions, totaling at least 2 million pounds U_3O_8 equivalent, must be included in each calculation, and that the sample time must be extended beyond three months as necessary to include these minima. Transactions included in the TV calculation generally are a subset of those listed under the category "Uranium Sales" in the *Current Market Data* section of each Report. Because of the inclusion of transactions from at least three months, the TV historically trails the movement of the Exchange Value (EV). In addition, because the TV is a historical indicator based solely on prices paid for uranium, it is subject to influence by premium or discount prices, while the EV may not be.

The TV opened 1986 at \$16.55 per pound, trailing the \$17.00 EV as a reflection of lower prices paid in the last

quarter of 1985 (Table 8). Following a two-month increase of the EV to \$17.25 in the second quarter, the TV passed the EV on May 31, 1986 and thereafter remained in the range of \$17.15 to \$17.50 for the balance of the year, compared to the EV's range of \$17.00 to \$16.75. Premiums paid by US utilities for US-origin material heavily influenced the TV in the second half. Those premiums, generally in the range of \$0.25 to \$1.00 per pound U_3O_8 relative to the EV, more than offset discounts obtained by some buyers for non-US origin. The Transaction Values for January 31, 1986 through December 31, 1986 included a total of 43 transactions and a total quantity of 7.05 million pounds U_3O_8 equivalent. The weighted annual average Transaction Value includes only those transactions and each is counted only once. The sum of the 1986 transaction quantities is divided into the sum of price times quantity calculations, giving a weighted average for the 1986 transactions included in the TV. This average is *not* the same number as would be found by simply averaging all twelve months' Transaction Values.

Table 8
1986 TRANSACTION VALUES¹
(and associated parameters)

Calculated as of the Last Day of the Month	Report Number	Transaction Value (per lb. U_3O_8)	Millions of Pounds	Number of Transactions	Number of Months
January	210	\$16.55	2.2	13	4
February	211	\$16.70	2.6	16	5
March	212	\$16.70	2.7	18	6
April	213	\$17.10	2.3	19	5
May	214	\$17.15	2.1	13	4
June	215	\$17.20	2.2	14	3
July	216	\$17.50	2.5	13	3
August	217	\$17.45	2.6	14	3
September	218	\$17.35	2.4	13	3
October	219	\$17.25	2.4	13	3
November	220	\$17.30	2.0	13	3
December	221	\$17.35	2.1	14	4
Annual Average		\$17.32 ²	2.3	14	4

¹ The Transaction Value is a weighted-average price of recent natural uranium sales transactions. The calculation is based on prices paid in:

- Transactions closed within the previous three-month period for which delivery is scheduled within one year of the transaction date;
- At least ten transactions;
- Transactions involving a sum total of at least 2 million pounds U_3O_8 equivalent.

—The sample time is extended as necessary to include these minima. Other currencies are converted to US dollars using conversion rates in effect on or near the transaction date.

² This average is a weighted average.

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Secondary Market Conversion

After rising sharply during 1985, the Conversion Value remained in a narrow range between \$1.80 and \$1.90 per pound U as UF₆ (approximately \$4.00 per kgU as UF₆) for most of 1986 (Table 1). In contrast to prior years, fewer utilities attempted to dispose of unwanted conversion commitments with primary suppliers during 1986, and those that did asked for prices at or above the Conversion Value. Nevertheless, conversion demand was also weak (Table 9). Competitive UF₆ prices caused those utilities not covered to purchase UF₆ rather than conversion alone. Nuexco reported eight secondary conversion sales during 1986 (Table 10) involving a total of approximately 2.3 million pounds U as UF₆ (1.06 million kgU as UF₆). In most cases, intermediaries with UF₆ in stock who were able to arrange *deconversion* transactions completed the sales, while US utilities accounted for seven of the eight buyers. Transaction prices usually were agreed at or slightly below the current Conversion Value.

Natural Uranium Loans

In June 1986, the Loan Rate declined from five percent per annum, where it had been since March 1985, to four percent. Thereafter, the Loan Rate did not change (Table 1). The loan market remained largely inactive during the year. Potential lenders appeared willing, but potential borrowers, often producers needing material that they could sell in order to finance production, frequently found security requirements too restrictive for attractive loan terms. Demand remained low to nonexistent throughout the year (Table 9). Nuexco is aware of several transactions that took place in 1986 (Table 10); however, those transactions involved many special circumstances and conditions and only two were reported. Another factor inhibiting activity in the loan market has been the continuation of low spot uranium prices, which has made purchasing more attractive than borrowing. The uncertainty over future prices for US-origin uranium has also deterred borrowing. If uranium prices escalate rapidly, the increased cost of replacement of borrowed material could be higher than loan costs.

Table 9
1986 SUPPLY AND DEMAND FOR SECONDARY MARKET CONVERSION¹
AND NATURAL URANIUM LOANS²
(Active³ inquiries as reported by Nuexco)

Determined as of the Last Day of the Month	Report Number	Conversion Supply (thousands of pounds U as UF ₆)	Conversion Demand (thousands of pounds U as UF ₆)	Loan Supply (thousands of pounds U ₃ O ₈ equivalent)	Loan Demand (thousands of pounds U ₃ O ₈ equivalent)	Exchange Value
January	210	575	0	5,300	0	\$17.00
February	211	865	950	5,300	0	\$17.00
March	212	975	950	5,300	0	\$17.25
April	213	825	625	5,300	0	\$17.25
May	214	1,700	565	5,300	0	\$17.00
June	215	1,700	565	5,300	0	\$17.00
July	216	1,700	565	5,300	0	\$17.00
August	217	1,300	1,000	5,300	0	\$17.00
September	218	1,965	650	5,300	0	\$17.00
October	219	1,965	650	5,300	0	\$17.00
November	220	1,415	650	5,300	0	\$16.75
December	221	750	900	4,500	0	\$16.75

¹For delivery within three years.

²Data refer to spot and near-term demand, i.e. material to be delivered to the borrower within one year.

³Involving competitive price, terms, and other conditions.

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Long-term Uranium Contracting

Relatively few utilities contracted for new long-term supplies during 1986, as large unfilled requirements generally will not begin to appear worldwide until the early 1990s. Long-term contracting activity did, however, increase somewhat since 1985. Many US utilities who might have been inclined to sign new contracts delayed their decisions pending the outcome of the UPA-DOE lawsuit. Australian and Canadian producers obtained a few new contracts in the USA, while African producers extended some contracts in Europe. The general marketing activities of the various producers are reviewed in the individual country sections of this Report.

Table 10

1986 URANIUM LOANS AND SECONDARY MARKET CONVERSION TRANSACTIONS REPORTED BY NUEXCO

	Loan Transactions	Secondary Market Conversion Transactions
Number of Transactions	2	8
Quantity	228,000 lbs. U ₃ O ₈ equiv. (87,300 kgU as UF ₆)	2,337,000 lbs. U as UF ₆ (1,060,000 kgU as UF ₆)

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SECONDARY MARKET ENRICHMENT SERVICES

Price Movements

As shown in Table 11, Nuexco SWU Values remained relatively constant throughout 1986, reflecting a quiet secondary market compared to prior years. Much of the secondary market in 1984 and 1985 had been created artificially by DOE's terms of conversion to the Utility Services enrichment contract (USEC), and consisted mainly of sellers with excess DOE commitments and Utility Services contract "offset" buyers. This market ceased to exist in the first quarter of 1986, following the expiration of the 180-day notices for the end of FY86. Most excess DOE commitments were excused at the end of the fiscal year due to conversion to the USEC, creating a market in which the amount of SWU held in inventory by DOE customers began to decrease rapidly.

The secondary market during 1986 was chiefly composed of a small number of utility buyers who had decided to procure their SWU on the spot market. These were generally holders of DOE requirements contracts who chose not to convert to the Utility Services contract. Most of those buyers eventually were able to find SWU available at the \$80 per SWU level. The key to getting a good price was flexibility in enrichment assay. Most sellers had enriched uranium product (EUP) in inventory, so that when they were prepared to sell, their material usually would have to be upgraded to a buyers' specific requirements. Buyers wanting upgrade or so-called "virgin" SWU often paid substantially more, between \$85 and \$90 per SWU.

A fundamental perception of uncertainty regarding DOE's long-term position in the primary enrichment market also affected the secondary market for enrichment services during 1986. DOE's policies regarding future technologies, such as centrifuge or laser isotope separation, vacillated throughout the year. And in response to US government initiatives, several private sector firms examined a possible entry into the enrichment business.

The continuing uncertainty over the outcome of the US producers vs. DOE lawsuit, which could decide the legality of the Utility Services contract and DOE's new criteria, also affected market decisions. Some DOE customers continued to threaten to terminate deliveries and buy on the secondary market should an embargo be imposed on DOE's enrichment of non-US-origin uranium. All of these issues, however, tended to overshadow some important perceptual and structural changes that took place in the secondary market in 1986, and which will affect the secondary market into 1987.

1. DOE's incentive price offer, combined with the FY87 base price of \$119 per SWU and DOE's promises of even

Table 11

1986 SWU VALUES

Determined as of the Last Day of the Month	Published in Report Number	Nuexco SWU Value
January	210	\$80
February	211	\$80
March	212	\$80
April	213	\$80
May	214	\$75
June	215	\$78
July	216	\$78
August	217	\$78
September	218	\$78
October	219	\$78
November	220	\$80
December	221	\$80
Annual Average		\$78.75

lower prices, convinced most market participants that DOE primary SWU prices will continue to decrease in the near future. Therefore, during 1986 some inventory holders began reevaluating the idea of selling their excess, and they are expected to enter the market as sellers.

2. DOE has, in effect, offered SWU for sale to spot buyers at the incentive price of \$90 per SWU. As long as this practice continues, it will effectively put a ceiling on secondary market prices.

3. The drop in the value of the dollar versus various European currencies has increased the prices of Eurodif and Urenco SWU relative to DOE SWU, making SWU from those suppliers much less attractive to US utilities. Given the currency situation, European enrichers for the time being cannot be regarded as attractive alternatives to DOE as sources of cheap, long-term SWU. Combined with the uncertainties surrounding DOE's long-term position, many DOE customers continued to postpone decisions involving long-term SWU procurement strategy.

4. Another effect of the weakening dollar has been that dollar-based contracts negotiated between primary European enrichers and US utilities in past years have ceased to be advantageous to the European sellers. Since in many cases the prices are no longer attractive to the utilities either, a number of renegotiations and even terminations of such contracts can be expected, possibly creating new secondary market buyers.

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5. At the beginning of 1986, DOE agreed to waive the Variable Tails Assay Option (VTAO) fee for any year in which a USEC customer committed to take 100 percent of its requirements from DOE. Count III of the UPA lawsuit against DOE argued that the surcharge for the VTAO tends to reduce uranium consumption, therefore DOE should allow customers to vary their tails assays at no charge. In June of 1986, the district court ruled in favor of the producers and the decision was not appealed by DOE. Thus, for fiscal year 1987 and beyond there is no fee for tails assays up to 0.30 weight percent U₂₃₅.

6. Techsnabexport (TSE), the Soviet nuclear fuel trading organization, began making spot sales to western companies during 1986 at competitive prices. Prices offered were discounted off current Nuexco SWU Values to entice buyers; nevertheless, only a few companies (all but one of them in Europe) ventured to purchase. Most utilities, particularly in North America and the Far East, will not accept TSE-origin SWU because:

- Such purchases are seen politically to subsidize the Soviet economy and nuclear industry;
- Feed material of Australian, Canadian or US origin cannot be enriched at TSE without subsequent withdrawal of tails material, and;
- The government of the USSR (like the US government) insists on prior consent to retransfers of TSE-origin material.

1986 Secondary Market Enrichment Transactions

In 1986, Nuexco reported a total of 1.0 million SWU sold in 21 transactions, as shown in Table 12. In contrast to 1985, the quantity of Eurodif-origin SWU dropped drastically as the weakness of the US dollar effectively drove up costs of Eurodif SWU. More than two-thirds of the transactions reported were for 1986 delivery. Overall, about 66 percent of the SWU sold were of DOE origin, 17 percent came from

Eurodif, and 17 percent came from other sources. Transactions concluded in 1986 frequently involved very complex mechanisms, including trades, loans, and upgrades of existing inventories. The primary buyers in the US were two utilities which had terminated DOE requirements contracts and which had not committed for their requirements. In addition, several DOE customers bought smaller quantities to fill the allowed 30 percent of requirements not committed to DOE under the USEC contract. Outside the USA a former DOE adjustable fixed commitment contract holder made several major purchases. Major sellers also included DOE customers with excess commitments. Sales by traders to utilities in Europe and the USA accounted for about 40 percent of the total transactions, in both number and volume, during 1986. The above statistics do not regard back-to-back purchases as separate transactions.

DOE Terminations

Approximately six DOE USEC holders either notified DOE that they were terminating their contracts in 1986 or discussed possible terminations with DOE. According to the contract terms, utilities had to notify DOE by April 1, 1986 if they were going to terminate all or part of their 1986 deliveries. In response to the threat of further lost business, DOE notified its customers that termination notices could be delayed, first to December 1986 and then into 1987. DOE hoped to negotiate with these customers rather than accept their terminations.

Technology

In 1986 DOE implemented its June 1985 decision to abandon the gas centrifuge enrichment program (GCEP) and to continue the development of the Atomic Vapor Laser Isotope Separation (AVLIS) process. To keep pace with DOE, the French Commissariat a l'Energie Atomique (CEA)

Table 12

SECONDARY MARKET SWU TRANSACTIONS¹ REPORTED BY NUEXCO IN 1986

Delivery Period	Number of Transactions	Thousands of SWU	DOE-origin (percent)	Eurodif-origin (percent)	Other origin (percent)
1986	14	721	79	14	7
1987	7	319	38	21	41
Total	21	1,040	66	17	17

¹Only includes transactions which occurred in 1986. Does not include transactions for which Nuexco has incomplete or unreliable data. Some transactions may have been updated after original publication.

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announced a program to bring its SILVA atomic vapor laser process into operation by the mid-1990s. In Japan, progress continues on a program for laser isotope separation development. British Nuclear Fuels plc (BNFL) of the UK is exploring the laser process and the Urenco group is continuing with centrifuge development.

It now appears that DOE is willing to relinquish the US lead in the AVLIS technology in exchange for current budget savings. After spending \$80 million on AVLIS development in FY87, the Office of Management and Budget (OMB) cut out all development funds for AVLIS in its proposed FY88 budget. OMB argued that interim SWU costs would be cheaper without the AVLIS development expenditures, and AVLIS may be better suited to privatization and private development funding. Congressional review of the budget has not been completed, but there are strong indications that many congressmen will be opposed to abandonment of the AVLIS technology.

The French CEA has budgeted the equivalent of \$40 million for atomic vapor laser research in 1986, concentrating its efforts at the Saclay nuclear research center. A pilot plant producing about 100,000 SWU per year is scheduled to begin construction in 1990-1991. Construction of a demonstration module which would produce about 1 million SWU per year is tentatively planned for sometime after 1995.

The Japanese utilities and other nuclear industry participants, under the auspices of Japan Nuclear Fuel Industries (JNFI), budgeted the equivalent of \$117 million over five years to develop an atomic vapor laser pilot plant capable of producing between 1,000 to 5,000 SWU per year. JNFI and the Federation of Electric Power Companies (FEPC) also are continuing to develop centrifuge technology. A 100,000 SWU per year prototype plant is scheduled to begin operation in 1987, and a 1.5 million SWU per year plant will begin the first phase of construction in 1988, although the exact schedule for completion has not yet been determined.

Also in 1986, the American Enrichment Company (AEC) investigated the possibility of purchasing DOE's GCEP facility for the private production of enriched uranium in the USA. AEC met considerable resistance from DOE, which may have considered a potential GCEP operation as competition for its diffusion plants. Urenco has also held discussions with the NRC and several US utilities about establishing a centrifuge plant in the USA, based on the Urenco technology.

The DOE Enrichment Program

After two years of successfully maneuvering to minimize its loss of market share, DOE lost much of its momentum in

1986. Most of DOE's efforts in 1986 addressed Counts I and II of the UPA lawsuit, a Congressional review of new enrichment contracting criteria submitted to bolster its position in the lawsuit, and a separate lawsuit by Duke Power.

The Uranium Producers vs. DOE Lawsuit

In December 1984, three US producers filed a five-count lawsuit against DOE. *Count I* requested a reimposition of the US embargo on foreign uranium. It asserted that, under the Atomic Energy Act (161(v), 42 U.S.C. 2201(v), enacted in 1964), DOE is obliged to limit the enrichment of foreign-origin uranium for domestic end uses so as to "assure the maintenance of a viable domestic uranium industry." The producers asked the court to take three actions under this count:

- a. To declare the meaning of the term "viable" as employed in 161(v);
- b. To order DOE to begin proceedings leading to the adoption of limits on enrichment of foreign-source uranium for domestic end use;
- c. To order DOE to impose interim limitations on such enrichment, pending the outcome of such proceedings.

In *Count II*, the suit sought a declaration that the USEC is null and void and an order prohibiting DOE from adopting a generic enrichment contract without compliance with the Administrative Procedures Act.

Count III sought to require DOE to allow customers to vary their tails assays at no charge, because the surtax for the variable tails assay option (VTAO) under the USEC tends to reduce uranium consumption.

Count IV sought to prohibit the use of the federal government stockpile; either through sales of pre-production inventories or through over-feeding the enrichment cascades to save power costs.

Count V sought judicial validation and enforcement of the principle that the US industry shall be maintained in a condition such that it shall be capable of supplying 100 percent of US requirements at any time, and under any hypothetical supply disruption.

In September 1985, US District Court Judge Jim Carrigan ruled in favor of the producers in Count II of the lawsuit. In June 1986, he ruled on the remaining counts in the lawsuit, Counts I, III, IV, and V. The producers had asked the Court to order DOE to commence a rulemaking leading to the adoption of limits on the enrichment of limitations on such enrichment pending the outcome of those proceedings. Carrigan ruled that DOE had violated the Act, denied DOE's

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requests to stay the proceedings, and granted the producers' motion for summary judgment.

DOE filed a Notice of Appeal and motion for stay pending appeal within several days of the District Court ruling. By early July, however, Judge Carrigan had not responded. DOE then took the stay request to the Tenth Circuit Court of Appeals (which has jurisdiction over matters under appeal from the District Court). DOE's application to stay the order was heard by three Circuit Court judges, who ruled on July 21 that the order is stayed until further order of the Circuit Court. Furthermore, the Circuit Court ordered that the issues involving Count I should be argued and submitted together with the issues of Count II, in an expedited hearing on September 11, 1986. Count II had been under appeal in the Tenth Circuit Court since September 1985. Thus, DOE was not required to comply with the order to implement restrictions on the enrichment of foreign-origin uranium for use in US plants until the viability of the US industry is restored.

The primary thrust of DOE's appeal, with respect to Count I, was based on its assertion that 161 (v) is not mandatory if restrictions on imports would have no favorable effect on the viability of the domestic industry. In other words, DOE argued that it has the discretion under the statute to determine if restrictions would be of any value, and if it determines that restrictions would not help the domestic industry, then DOE need take no action with respect to imports. The producers (with concurrence by Judge Carrigan) argued that the statute is clear and that DOE lacks the discretion to interpret the statute.

Among other reasons, DOE stated that:

— DOE already had in its possession a high percentage of foreign feedstocks designated for use in US reactors. DOE claimed the order would prevent it from enriching all of the delivered feedstock needed for US reactors. Therefore, domestic utilities and DOE would suffer "irreparable" injury without a stay," which "could result in shutdowns of domestic reactors."

— The injunction "impacts adversely on foreign trade, foreign policy, and the nuclear non-proliferation policy of the United States," and is not in the public interest.

Under Count II of the suit, Judge Carrigan had stated that the critical issue regarding the USEC was that it "[amounted] to new criteria governing enrichment." He cited three examples:

1. Existing criteria require that the primary DOE enrichment contract must be of a Fixed-Commitment type, which the USEC clearly is not.

2. The USEC sets a ceiling price for enrichment services, which conceivably could prevent the government from

recovering its costs. For the same reasons, the provision in the original criteria which guaranteed a ceiling price was eliminated by the aforementioned 1973 revision.

3. Provisions in the USEC that base termination penalties on the period of notice that the customer gives DOE, rather than on estimates of costs that will be incurred as a result of customer terminations, should be considered new criteria.

After the District Court ruled that the Contract was unlawful, null and void, DOE also appealed that ruling. While most of the industry expected a decision to be issued before the end of 1986, there still has been no ruling as of March 1987.

Enrichment Criteria

Even while DOE appealed the District Court's decision, it attempted to resolve some of the problems that had contributed to the lawsuit. Starting with a notice of proposed rulemaking on January 29, 1986, DOE had been engaged in the rulemaking process with respect to enrichment services criteria (as opposed to a rulemaking on enrichment of foreign origin uranium ordered by Carrigan, which DOE has not commenced). The actual criteria consisted of fifteen subsections (762.1-762.15) covering many aspects of contracts, feed specifications, prices, costs, and other pertinent issues. DOE requested written comments on the proposal by February 28, 1986, and held a public hearing on the matter in March. On April 25, 1986, DOE extended the written comment period for another 30 days, to provide for "requests for further analysis with respect to those provisions of the proposed uranium enrichment criteria which relate to (1) the 'enrichment of foreign origin uranium' and (2) the 'recovery of prior government costs.'" On July 24, DOE's final wording of the criteria had been established and was submitted to Congress for the 45-day obligatory review, appearing in the Federal Register on July 29, 1986. In general, the proposed criteria submitted to Congress in July were not substantially different from the language issued for review and comment in January, 1986.

Various committees in both houses of Congress had expressed opposition toward some aspects of the proposed criteria (the Senate voted to disapprove the criteria in adopting the Senate's version of the debt ceiling resolution). But Congress unexpectedly failed to attach the resolutions to any pending legislation, and failed to disapprove the proposed criteria within the 45-day review period. Therefore, DOE argued that the criteria became effective. However, Congress finally did take action on October 15, 1986, within the context of the Continuing Resolution on appropriations for FY87. It effectively nullified those sections of the new criteria that had

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caused the most controversy by passing a joint resolution with the following introduction:

"None of the funds provided in this joint resolution or in any other law may be used to implement the following provisions of the uranium enrichment criteria submitted to Congress on July 24, 1986."

In effect, the resolution provided for funding of the new criteria, *except* for five important sections. Those sections denied government funding (effectively making them difficult to implement) were the following.

1. Section 762.3, which specifies the permitted enrichment of source material of foreign origin for use in domestic utilization facilities;

2. The third sentence of section 762.11, pertaining to quantities and form of feed and product material; this meant that DOE must provide a free Variable Tails Assay Option (VTAO);

3. Section 762.15, pertaining to prior enrichment contracts; DOE cannot implement this section in order to circumvent a court decision requiring foreign-origin uranium restrictions or a VTAO surcharge;

4. The practice of over-feeding from the DOE stockpile;

5. A determination of the level of unrecovered costs that must be returned to the Treasury by the enrichment program; the issue of the size of DOE's enrichment debt will be postponed until Congress reviews it again, probably in the session beginning in January 1987.

DOE and the US producers submitted statements and memoranda to the Appeals Court concerning this congressional action. DOE argued that Congress had ratified the criteria, at least in part, and validated the new USEC, rendering Carrigan's order as to Count II and the appeal moot. Conversely, the lawyers for the producers argued that Congress did nothing except withhold funds, which is all they could do within the limits of an appropriations resolution. They argued that appropriations or failure to appropriate funds does not constitute a judgment on the validity of substantive issues that are part of a law.

The Duke Power Litigation

On September 22, 1986 Duke Power Company filed a petition with the US Court of Appeals for the District of Columbia challenging the new enrichment criteria promulgated by DOE. In particular, Duke challenged those portions

dealing with recoupment of prior unrecovered government costs, enrichment of uranium of foreign origin, and those parts of the USEC affected by those issues. Duke also took the position, contrary to either the producers or DOE, that any embargo of foreign material was intended by Congress to be a one-time remedy and that all import restrictions were to be phased out after 1983.

Ironically, in February 1984, Duke Power was the first utility customer to sign DOE's new USEC contract. In early 1986, Duke was still supporting the new DOE enrichment criteria, and was actively pressing for their adoption by Congress. Duke's position changed from support to opposition when DOE made a last-minute change to the criteria prior to their submission to Congress. DOE changed its valuation of the enrichment enterprise's debt to the Treasury (to be recovered from future enrichment customers, including Duke) from \$360 million to \$3.6 billion.

DOE argued that Duke filed its lawsuit in the wrong court; i.e., that the Court of Appeals lacked jurisdiction and that the US District Court was the proper forum. To add confusion, the National Taxpayer's Union (NTU) filed an *amicus curiae* memorandum supporting DOE's motion to dismiss the Duke petition but for only one of the reasons stated by DOE. At the same time NTU agreed with Duke that the DOE enrichment criteria violate the law, but for reasons exactly opposite those advanced by Duke. NTU said that in asserting there is no debt to be recouped, Duke in essence wanted a \$7.5 billion subsidy. NTU believed that since the DOE criteria and USEC effectively discard an alleged \$4.1 billion in debt, and 161(v) requires full cost recovery over a reasonable period of time, they are both wrong. The NTU added that the criteria also violated Section 169 of the Atomic Energy Act, because it amounted to a subsidy to a licensed nuclear reactor. NTU agreed with DOE that the proper forum for Duke's petition is the District Court, not the Court of Appeals. However, it disagreed with DOE's contention that the Continuing Resolution substantiated or confirmed the criteria. NTU's position was that nothing in the Continuing Resolution could be construed to override the substantive deficiencies in the criteria.

The Duke case has stalled over the issue of jurisdiction. It is possible that the decision in the Tenth Circuit will, though not rendering all related issues moot, cause the Duke case ultimately to be dismissed.

NUEXCO

MARKET DEVELOPMENTS

WORLD URANIUM PRODUCTION

Uranium production in 1986 totaled approximately 96.3 million pounds U_3O_8 ; that figure was 7 percent higher than 1985 (Table 13), but 17 percent below the record level of 115 million pounds attained in 1980 and 1981. Production in Australia, Canada, and the USA increased from 1985, while South African production decreased slightly.

Table 13

WORLD URANIUM PRODUCTION IN 1985 and 1986
(Millions of Pounds U_3O_8)

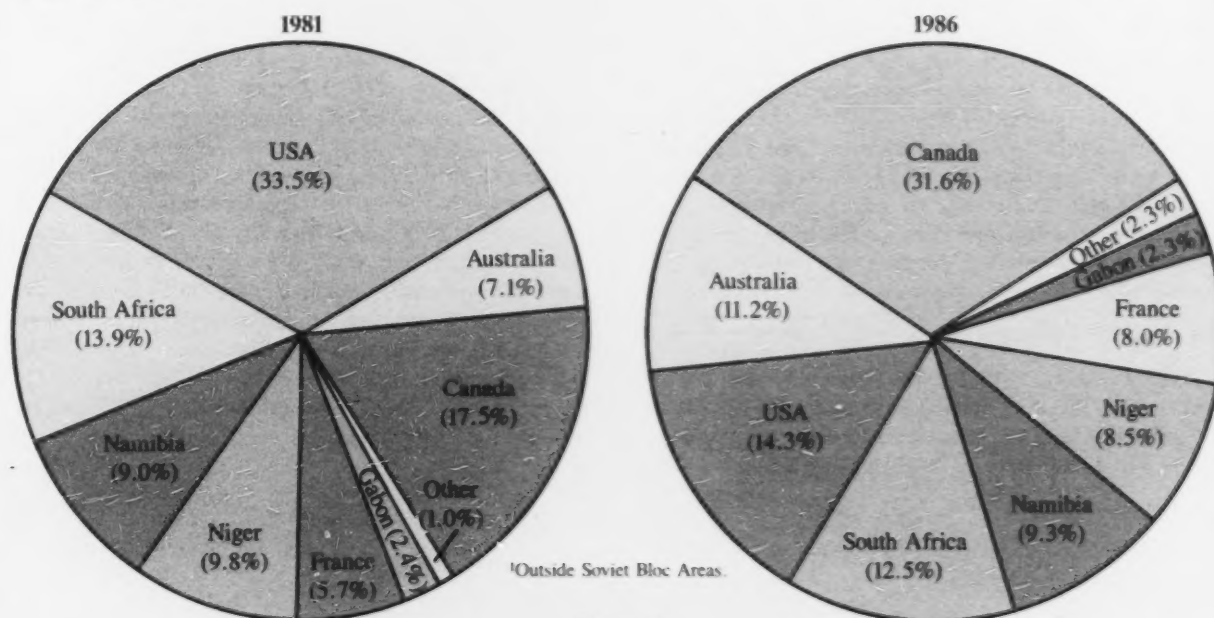
Country	1985	1986	Percent Change
Australia	8.5	10.8	+ 27
Canada	28.3	30.4	+ 7
France	8.3	7.7	- 7
Gabon	2.3	2.2	- 4
Namibia	9.0	9.0	0
Niger	8.2	8.2	0
South Africa	12.7	12.0	- 6
United States	11.3	13.8	+ 22
Other ¹	1.8	2.2	+ 22
WORLD TOTAL	90.4	96.3	+ 7

¹Includes Argentina, Belgium, Brazil, China, India, Pakistan, Portugal, Spain, and Yugoslavia.

Changes in Market Share

As worldwide uranium production has declined since 1981, the percentages of the total supplied by several producing countries have shifted noticeably (Figure 3). The greatest changes involve the relative positions of Canada and the USA. Canada's market share almost doubled, increasing from 17.5 percent in 1981 to 31.6 percent in 1986. By contrast, the USA's market share has been more than halved, as it declined from 33.5 percent in 1981 to only 14.3 percent in 1986. Australia's production increased from 7.1 percent in 1981 to 11.2 percent in 1986. South Africa's market share declined from 13.9 percent in 1981 to 12.5 percent in 1986. Taken together, the overall market share held by the USA and South Africa declined by 20.6 points, while that held by Canada and Australia increased by 18.2 points.

Table 14 presents Nuexco's estimates of historical world production for 1981 through 1986. Although estimates made at the end of each year are reasonably accurate, Nuexco regularly updates this information based on official production results and other new information.



¹Outside Soviet Bloc Areas.

Figure 3

MARKET SHARE OF WORLD¹ URANIUM PRODUCTION, 1981 AND 1986

MARKET DEVELOPMENTS

1986 Results

Australia's 1986 production increased 27 percent, from 8.5 million pounds U_3O_8 in 1985 to 10.8 million pounds in 1986. Nearly all of the increase came from Energy Resources of Australia's Ranger operation, which operated at greater than rated capacity throughout the year. Ranger output rose from 5.6 million pounds in 1985 to 7.7 million pounds in 1986. Output from Queensland Mines' Nabarlek project increased slightly during 1986, as the company processed ore stockpiled at the mill site.

Canadian production increased by over 2 million pounds U_3O_8 , to a new record of 30.4 million pounds, and for the third consecutive year, Canada led the world in uranium production. Saskatchewan accounted for 59 percent of Canada's total; Key Lake produced 12.6 million pounds; and Cluff Lake totaled 2.1 million pounds. In addition, the expansion of the Rabbit Lake mill facilitated an almost 50-percent rise in output, to 3.2 million pounds. In Ontario, production from Rio Algom's combined operations remained virtually unchanged, while Denison Mines' output decreased slightly.

Uranium production in the Republic of South Africa continues to decline, dropping six percent in 1986, to 12.0 million pounds U_3O_8 . Output fell at Harmony Gold Mining Ltd. (23 percent), Buffelsfontein (16 percent), Freegold, formerly Free State Joint Metallurgical Scheme (12 percent), and the Western Areas (15 percent). Other Chamber of Mines producers reported production at levels approximately equal to 1985 results or slightly higher. Harmony shut down its Virginia plant in 1986. Palabora Mining Company, Ltd. decreased production 9 percent from 1985 levels, to 436,000 pounds U_3O_8 . South Africa dropped to third place in world uranium production in 1986, behind Canada and the USA.

US output rose 22 percent in 1986, to 13.8 million pounds. Conventional production accounted for 63 percent of the total, almost two-thirds of which came from the operations of Chevron, and Energy Fuels and its Swiss partners. By-product recovery produced 3.6 million pounds, 26 percent of the total, while solution mining operations produced 1.5 million pounds, or 11 percent of the US total.

Table 14
HISTORICAL WORLD¹ URANIUM PRODUCTION², 1981-1986
(Millions of pounds U_3O_8)

Country	Production/Market Share ⁴		1982	1983	1984	1985	Production/Market Share ⁴	
	1981						1986	
Australia	8.1	(7.1%)	11.6	8.4	10.3	8.5	10.8	(11.2%)
Canada	20.1	(17.5%)	21.0	18.6	29.0	28.3	30.4	(31.6%)
France	6.6	(5.7%)	7.8	8.5	8.2	8.3	7.7	(8.0%)
Gabon	2.7	(2.4%)	2.5	2.6	2.3	2.3	2.2	(2.3%)
Namibia	10.3	(9.0%)	9.8	9.7	9.6	9.0	9.0	(9.3%)
Niger	11.3	(9.8%)	11.1	8.9	8.5	8.3	8.2	(8.5%)
South Africa	15.9	(13.9%)	15.1	15.7	14.9	12.7	12.0	(12.5%)
United States	38.5	(33.5%)	26.9	21.2	14.9	11.3	13.8	(14.3%)
Other ³	1.1	(1.0%)	1.9	1.7	1.7	1.8	2.2	(2.3%)
WORLD TOTAL	114.8		107.7	95.3	99.4	90.4	96.3	
(rounded)	115		108	95	99	90	96	

¹Outside Soviet bloc areas.

²Figures presented are Nuexco's best estimates.

³Includes Argentina, Belgium, Brazil, China, India, Pakistan, Portugal, Spain, and Yugoslavia.

⁴Expressed as a percentage of total production. Column may not equal 100 percent due to rounding.

AUSTRALIA

AUSTRALIA

Introduction

Australia's position in the international uranium market was enhanced as a consequence of a number of events that occurred during 1986.

1. The government decided to lift its ban on uranium shipments to France.
2. The Olympic Dam joint venture concluded its first long-term sale (to the Swedish State Power Board).
3. Energy Resources of Australia (ERA) had continued success in its aggressive US marketing drive.
4. The Australian government is becoming more pragmatic and realistic with respect to its establishment and implementation of commercial policies.

Political Developments

The government's increasing pragmatism was evident when it decided to allow Queensland Mines Limited (QML) to resume uranium shipments to Electricite de France (EdF). Those shipments had been banned for two years, and the Australian government had been purchasing the uranium that QML otherwise would have delivered to EdF. The ban had been imposed by Australia in an attempt to force curtailment of France's nuclear weapons testing in the South Pacific. However, it had become evident that the ban was counterproductive, because EdF was able to purchase uranium from other sources at lower prices, and the Australian government was forced to expend funds needed for other programs to purchase uranium for which Australia has no need. Furthermore, the ban had no effect on France's nuclear test program, and also brought into question Australia's reliability as a long-term uranium supplier. Lifting the ban was a victory for commercial reality over political rhetoric.

A primary obstacle impeding Australia's movement into the front rank of uranium suppliers has been the government's rigid floor-price policy. During the past year, however, there have been clear signs that this situation is likely to change. The government's actions, current and anticipated market developments, and a wide spectrum of informed opinion all point to recognition that rigid controls will be counterproductive. For Australia, with its emphasis on long-term relationships, flexible, realistic, and reliable policies are essential to its credibility as a reliable source of supply.

It now appears that the implementation of the floor-price policy is aimed at ensuring that the average price exceeds the US\$31.00 per pound U_3O_8 floor price over the life of a contract. Thus, a long-term contract with deliveries beginning in 1990 could be expected to average more than US\$31.00, if priced today in the mid-\$20 range with index

escalation. Furthermore, late in the year there were recurrent reports that officials were considering a reduction in the level of the floor price.

Production Results

Ranger — Production at ERA's Ranger mine and mill at Jabiru increased to 7.7 million pounds U_3O_8 in 1986, 1.1 million pounds in excess of its rated capacity of 6.6 million pounds U_3O_8 . ERA has announced plans for a two-stage doubling of capacity by the early 1990s.

ERA's marketing efforts in the USA resulted in additional contracts, and the company now holds nine long-term sales agreements, the most recent of which are with Florida Power & Light, South Carolina Electric & Gas, and Southern California Edison. Agreements were reached earlier with American Electric Power, Pennsylvania Power and Light, Philadelphia Electric, Portland General Electric, Virginia Electric Power, and Wisconsin Electric Power.

Because of Australia's floor-price policy, as well as many US customers' desire to pay near spot-market prices, ERA's contracts with US buyers contain provisions for price protection and other incentives, such as flexible timing and quantity for deliveries and discounts from spot price when or if it exceeds the floor price. In order to avoid certain long-term delivery and payment obligations for uranium at higher than spot-market prices, other conditions provide for deliveries to be reduced, suspended, or terminated if certain price or quantity-related triggers are reached. In addition, some contracts provide protection in the event of US import restrictions.

ERA came under pressure from its shareholder-customers either to reduce the prices payable by them or face the prospect of those supply agreements being terminated as early as the end of 1990. These entities have been bound by their contracts to accept delivery of large quantities of uranium at prices considerably higher than either spot-market prices or those typically agreed upon as a consequence of annual price negotiations. Negotiations to resolve this issue were continuing as of the end of 1986, with shareholder-customers insisting on prices below their current floor price of US\$30.09 per pound U_3O_8 . Of course, such a reduction would violate current, officially enunciated Australian policy, and bring further into question the entire issue of government-imposed commercial terms.

Olympic Dam (Roxby Downs) — The commitment by the joint venture partners Western Mining and BP Australia to proceed with the Olympic Dam project was one significant achievement for 1986. The signing of the first long-term uranium sales contract, with the Swedish State Power Board

AUSTRALIA

(SSPB), was the other. The SSPB agreement involves about 550,000 pounds U_3O_8 annually for the period 1989 to 1999. A second contract, with the UK's Central Electricity Generating Board (CEGB), was also close to completion at the end of 1986, and was concluded in January 1987. Other on-going negotiations are expected to result in additional contracts during 1987. In marketing its future production, Olympic Dam has had to overcome its handicap as a new, untested supplier in the marketplace by presenting itself as a viable alternative to ERA. As long as the floor-price policy remains in effect, competition based on price is not likely, so Olympic Dam's marketing emphasis has been one of flexibility and service. Olympic Dam's output is targeted at 4.4 million pounds U_3O_8 annually, with first production scheduled for mid-1988.

Development of the mine and associated infrastructure continued to accelerate throughout the year and by year end the on-site work force numbered nearly 900, and roads, utility services, and other necessary infrastructure are under construction.

Nabarlek — Queensland Mines Ltd. (QML) continued to mill stockpiled uranium at its Nabarlek site, producing nearly 3.1 million pounds U_3O_8 in 1986. QML's production is nearly all committed, with contracts to supply Electricite de France (EdF), two Japanese and one Finnish utility. When the government's ban on uranium shipments to EdF was lifted in mid-1986, the 800 tons U_3O_8 of blocked shipments, which the Australian government had been forced to buy, were redelivered to EdF before the end of the year.

With most of its material committed under long-term contracts and with the current Australian floor price nearly twice the current spot price level, QML finds itself in a difficult competitive position relative to ERA and Olympic Dam, both of which can offer long-term supply. QML's ability to offer long-term production depends on the outcome of its current negotiations with the Northern Land Council for exploration and development of new deposits in the Northern Territory. Negotiations with the NLC are ongoing, but at this time there can be no assurance of success.

NUEXCO

CANADA

CANADA

Uranium Production

Canada once again led the world in uranium production by a wide margin, accounting for over thirty percent of the world's output during 1986. Canadian production amounted to 30.4 million pounds U_3O_8 , an increase of two million pounds U_3O_8 over the 1985 figure (Table 15). The province of Saskatchewan produced 59 percent of the nation's total, as output from Key Lake exceeded 12.5 million pounds. Eldorado Resources Ltd. completed a C\$100 million mill expansion and modernization program at Rabbit Lake. The mill increased production by 48 percent during 1986, to 3.2 million pounds U_3O_8 . The increase was largely attributable to the milling of higher-grade ore from the "B" orebody of Eldorado's Collins Bay deposit. Amok Ltd. produced about 2.1 million pounds at its Cluff Lake operations. Within the province of Ontario, output remained at about 12.6 million pounds U_3O_8 ; 7.3 million pounds were produced at Rio Algom's Elliot Lake operations and 5.2 million pounds from Denison Mines Ltd.

The September 1986 results of an annual assessment of Canada's uranium supply, released by the Minister of Energy, Mines and Resources, confirmed the continuation of Canada's position as the world's leading producer and exporter of uranium. The report also included the following information.

1. As of the end of 1985, total recoverable resources in the measured, indicated and referred categories were estimated

at 545,000 metric tons of uranium (MTU), or about 1.4 billion pounds U_3O_8 .

2. Continued exploration and development in northern Saskatchewan resulted in a 19-percent increase in measured resources from 1984 to 1985. Seventy-five percent of Canada's uranium exploration expenditures went to northern Saskatchewan.

3. About 85 percent of the country's annual uranium production is destined for export.

4. The country's production should continue at an annual rate of approximately 30 million pounds U_3O_8 through 1990.

Exploration and development continued on the major uranium discovery of the last several years, the Cigar Lake deposit in Saskatchewan. The joint operating company, Cigar Lake Mining Corporation (CLMC), in 1986 proposed a C\$50 million underground exploration and test program. The company is awaiting environmental approval to proceed with the project. Indicated reserves in the main mineralized pod exceed 285 million pounds U_3O_8 , at an average grade of 14 percent U_3O_8 . An additional 100 million pounds U_3O_8 at an average grade of five percent U_3O_8 is believed to occur in a western extension of the main ore zone. Throughout 1986, a series of engineering and geological studies yielded detailed information about the orebody and its host rock, confirming the high-grade nature of the mineralization. The schedule for the project calls for site preparation to begin in 1987, completion of the shaft in 1988, and completion of underground

Table 15
CANADIAN URANIUM OUTPUT, 1985-1986

Company or Mine	Location	Production Thousands of Pounds U_3O_8	
		1985	1986
Denison Mines Limited	Ontario	5,490	5,239
Rio Algom Limited	Ontario		
— Quirke		3,543	3,500
— Panel		2,150	2,100
— Stanleigh		1,781	1,700
Amok Ltd.	Saskatchewan	2,171	2,100
Eldorado Resources Ltd. (Rabbit Lake)	Saskatchewan	2,142	3,190
Key Lake Joint Venture	Saskatchewan	11,101	12,566
TOTAL		28,378	30,395

CANADA

testing by 1990. Startup is scheduled for the early 1990s, using a tentative production target of 12 million pounds U_3O_8 per year.

The future of uranium mining, exploration and development in the province of Saskatchewan received some assurance in October 1986, as the Progressive Conservative provincial government was reelected to an additional four-year term. Although the party holds a slightly smaller majority in the Saskatchewan Legislature than it did previously, its victory ended speculation over a New Democratic Party (NDP) victory. Some elements within the New Democratic Party expressed strong anti-uranium and antinuclear sentiment, and its election could have meant a slowdown in the development of the Cigar Lake project, among others. Although the NDP won all but one legislative seat in the province's four largest cities, the Progressive Conservatives gathered enough votes in rural Saskatchewan to remain in power.

The subject of Canada's uranium upgrading policy, which in most cases requires uranium sold abroad to be upgraded to UF_6 at Eldorado Nuclear's conversion facilities, was again the

topic of discussions during 1986. Canadian and US trade officials have included uranium in their negotiations for freer trade policies between the two nations, although talks usually focused on the products of larger industries. However, the US imposition of tariffs on goods such as lumber and pharmaceuticals, sometimes followed by Canadian reprisals, has stood in the way of serious attempts to ease trade restrictions. In light of these difficulties, as well as the prospect of some type of US limitation on the use of non-US uranium, the Canadian government is not likely to alter its upgrading policy in the near future. However, in order to avoid hindering sales of Canadian uranium, it is quite likely that the government will continue to grant exemptions to the policy whenever commercially essential.

Eldorado Nuclear's Fuel Services Division processed a record volume of uranium in 1986. Production rose 21 percent to 8,239 metric tons of uranium, as production of both UF_6 for export and UO_2 increased. On average, UF_6 production accounts for about 85 percent of Eldorado's processing operations, and UO_2 for CANDU fuel accounts for about 15 percent.

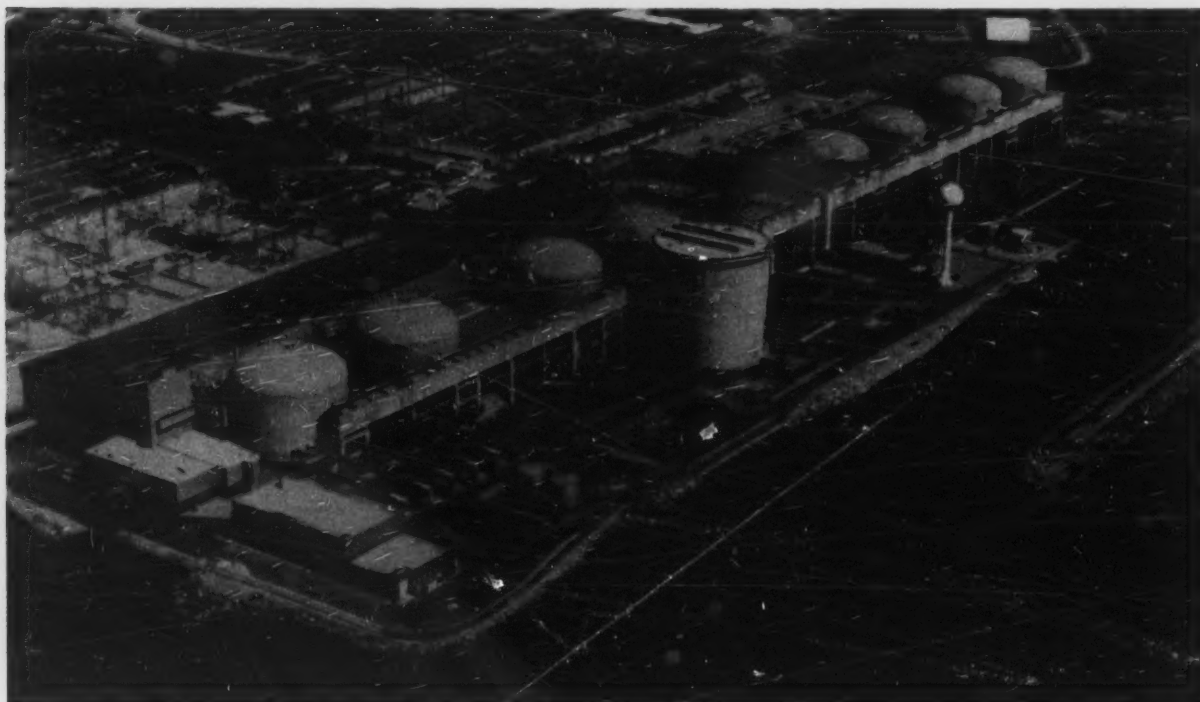


Figure 4. Ontario Hydro's eight-unit, 4,120-MWe Pickering station, located on the shore of Lake Ontario, about 50 kilometers east of Toronto. Units 1 and 2 are currently shut down for retubing.

CANADA

Nuclear Power Developments

One CANDU reactor entered commercial service in 1986 (Table 16). Ontario Hydro's Bruce Unit 7 began commercial operation in April 1986. The last unit at the station, Bruce Unit 8, is 100-percent complete and is scheduled for commercial operation in July 1987. At that point, the Bruce station will be one of the largest nuclear generating stations in the world, responsible for slightly less than 6,000 MWe gross generating capacity, and increasing Canada's nuclear capacity to 11,350 MWe. Repair work is continuing on Pickering Units 1 and 2, which have been shut down for retubing for the past two years. Ontario Hydro expects Unit 1 to return to service in May 1987, followed by Unit 2 returning in December 1987.

The fate of the four-unit 3,520-MWe Darlington station was decided in the spring of 1986, when the Ontario provincial government approved its completion. The first unit is scheduled to begin commercial operation in November 1988.

The status of New Brunswick Electric Power Company's Point Lepreau Unit 2 remains uncertain. Lacking some commitment from utilities in the northeastern USA to purchase electricity that would be generated by Unit 2, it is doubtful that New Brunswick Power will begin construction on the unit.

Ontario Hydro and Rio Algom Limited, one of the utility's largest uranium suppliers, agreed to alter their long-term contract in order to reduce the quantity of uranium delivered in the 1986-1993 time period of the contract. The contract currently runs until 2020. In the period 1986-1993, the quantity of uranium to be purchased by Ontario Hydro will be reduced approximately 28 percent. This reduction is expected to eliminate most of the utility's oversupply of uranium during that period. Denison Mines also has a large supply contract with Ontario Hydro, and the utility will be discussing with both suppliers, further renegotiations for the post-1993 period.

Table 16
NUCLEAR POWER PLANTS IN CANADA

Utility	Unit	MWe (net)	Percent Complete	COD ¹	
In Commercial Operation					
Ontario Hydro	Pickering 1*	515	100	Jul	1971
	Pickering 2*	515	100	Dec	1971
	Pickering 3	515	100	Jun	1972
	Pickering 4	515	100	Jun	1973
	Pickering 5	515	100	May	1983
	Pickering 6	515	100	Feb	1984
	Pickering 7	515	100	Jan	1985
	Pickering 8	515	100	Feb	1986
	Bruce 1	740	100	Sep	1977
	Bruce 2	740	100	Sep	1977
	Bruce 3	740	100	Feb	1978
	Bruce 4	740	100	Jan	1979
	Bruce 6	750	100	Sep	1984
	Bruce 5	750	100	Mar	1985
	Bruce 7	750	100	Apr	1986
New Brunswick EPC ²	Point Lepreau 1	630	100	Jan	1983
Hydro Quebec	Gentilly 2	640	100	Sep	1983
TOTAL		9,850			
Under Construction or Planned					
Ontario Hydro	Bruce 8	750	100	Jul	1987
	Darlington 2	880	81	Nov	1988
	Darlington 1	880	58	Aug	1989
	Darlington 3	880	24	Nov	1991
	Darlington 4	880	14	Aug	1992
New Brunswick EPC	Point Lepreau 2	630	0	Indefinite	
TOTAL		5,650			

¹COD = Actual or Expected Commercial Operation Date.

²EPC = Electric Power Company.

*These units are currently shut down for retubing.

CENTRAL AFRICA

CENTRAL AFRICA

Gabon and Niger uranium producers shared a distinction in 1986. As a result of both the threat of sanctions against South African and Namibian-origin uranium in Europe, as well as the enactment of sanctions in the USA, Niger and Gabon appear to be the most attractive countries of origin for many uranium buyers, particularly in Europe. That was true both for users who were sensitive to the political ramifications of southern African origin purchases, and for users that were enriching in the USSR or reprocessing. If buyers demonstrate a willingness to pay a premium for uranium of central African origin, it could stimulate a renewal of exploration activities in these countries.

One of the primary operators of uranium facilities in both Gabon and Niger, Cogema, announced that it had acquired Compagnie Francaise de Mokta (CFM) from Imetal. Thus, Mokta becomes a wholly-owned subsidiary of Cogema. Cogema and Mokta had separately been part owners in Comuf (Gabon) and Somair (Niger). The acquisition gives Cogema 57.8 percent interest in Comuf, and 46.3 percent interest in Somair.

GABON

Uranium production in Gabon totalled approximately 2.2 million pounds U_3O_8 in 1986, down slightly from the 1985 level. Gabonese production facilities are under the ownership of Comuf (Compagnie des Mines d'Uranium de Franceville), which operates the Oklo and Boyindzi mines and the 1,650 MTU capacity Mounana mill. Comuf is owned by a consortium, including Cogema (57.8 percent), Pechiney (13 percent), and the Gabonese government; Comuf leases the property from France's CEA (Commissariat a l'Energie Atomique). Uranium produced in Gabon is largely captive; nearly 70 percent of the output from the Mounana mill goes to Cogema, although other European and Japanese buyers also have short and medium term supply contracts.

Exploration for uranium continues in Gabon, by several groups of investors. Comuf maintains an exploration program in several areas; the Leyou-North Joint Venture consists of Cogema, the government of Gabon, and Korea Electric Power Corporation (KEPCO); the Franceville-South Joint Venture consists of Cogema (49 percent), the government of Gabon (10 percent), Urangesellschaft (25 percent), and Comuf (16 percent). The government of Gabon encourages

uranium exploration by exempting companies involved in exploration from import duties on machinery and equipment, and by deferring the write-off of expenditures for exploration against later earnings.

NIGER

Niger's two uranium projects together produced 8.2 million pounds in 1986, the same level as in 1985. Onarem (Office National des Ressources Minieres), the state-owned mineral resources company, maintains a subsidiary interest in both the Akouta mine and the Arlit project. In 1985, the published contract price for Niger uranium was 30,000 CFA per kgU for deliveries in that year. It is understood that the 1986 contract price is unchanged, reflecting the depressed state of the world uranium industry, after several years of price increases.

The Akouta mine is owned by Cominak (Compagnie Miniere d'Akouta), a consortium consisting of Cogema (34 percent), Onarem (31 percent), Japan's Overseas Uranium Resources Development Company (25 percent), and Enusa, the Spanish fuel-cycle company (10 percent). The mine is operated by Cogema, which purchases about half the project's output. Akouta is the world's largest underground uranium mine and, operating at near capacity, produced uranium at a cost of approximately \$20-25 per pound U_3O_8 , at 1986 exchange rates.

The Arlit project is an open-pit mine owned by Somair (Societe des Mines de l'Air). The shareholders in Somair are Onarem (33 percent), Cogema (27 percent), Compagnie Francaise Mokta (19.4 percent), Pechiney (7.6 percent), Urangesellschaft (6.5 percent), and Italy's Agip Uranio (6.5 percent). As with Akouta, Cogema is the project operator. Production at Arlit stabilized in 1986 at about half of its capacity of 1,200 MTU. Urangesellschaft and Agip Uranio, while retaining their shareholdings in Somair, have not purchased any of its output since 1984.

The scope of future uranium exploration in Niger appears to have been reduced in 1986. The partners in the East Afasto project, CEEB of the UK, Saarberg-Interplan of the FRG, as well as Onarem, Cogema and the government of Niger, met in 1986 to discuss the future of the joint venture. Only the Power Reactor and Nuclear Fuel Development Corporation (PNC) and other Japanese interests are seriously considering new ventures in Niger at the present time.

EUROPE

EUROPE

Overview

Nuclear power stations supplied a record amount of electricity to European countries during 1986, increasing the importance of the nuclear energy sector in western Europe. Nine new units entered commercial operation during the year, six of them in France. Nuclear energy provided 241.4 billion kilowatt-hours (kwh) in France out of the total national electricity production of 345.8 billion kwh. In the Federal Republic of Germany, PreussenElektra's Grohnde unit alone generated 10.75 billion kwh of power. The percentage of power generated by nuclear plants increased to around 70 percent in France and Belgium, 50 percent in Sweden, 38 percent in Switzerland, 34 percent in Finland and the FRG, and 30 percent in Spain (Figure 5). Consumption of fossil fuels continued to decline in most European countries.

Despite the importance of the nuclear energy sector, the European nuclear industry was damaged politically in 1986 by the catastrophic accident at Chernobyl in the USSR. That accident occurred in April, in a 950-MWe graphite-moderated reactor located near the city of Kiev, in the Ukraine, and resulted from an uncontrolled power excursion. Some 35 persons died in the accident or immediately after it. The radioactive materials released as a consequence of the accident were detected throughout Western Europe. This caused a wave of public concern in several countries, rekindling the debate over the use of nuclear power to an extent reminiscent of the aftermath of the 1979 Three Mile Island accident in the USA. Although the design of the Chernobyl reactor is substantially different from most commercial reactors in Western Europe, the accident forced every European government to reassess its nuclear power safety standards, and caused some governments to postpone plans for the construction of new power stations. Nevertheless, by the end of 1986 the accident had had a minimal impact on plants already operating and on most countries' established nuclear energy policies.

Some European utilities took advantage of low uranium prices in European currencies during 1986, but in general little contracting for new supplies took place as most companies drew from inventories and existing long-term contracts. Only a few new long-term contracts were signed. Most utilities also stayed out of the spot market, although at least four utilities concluded substantial spot purchases. As in North America, swaps and other unconventional transactions structured by traders and other intermediaries comprised a large share of the year's business. No European utilities were known to have concluded long-term contracts with primary

enrichers, as most recent enrichment contracting was concluded during 1984 and 1985. However, a few utilities did purchase SWU in the secondary enrichment market.

AUSTRIA

Following the Chernobyl accident, the Austrian government voted to abandon any plans to rehabilitate nuclear energy as a source of domestic power, thereby eliminating any chance that the mothballed Zwentendorf plant near Vienna would operate. The government's announcement enabled Gemeinschaftskraftwerk Tullnerfeld GmbH (GKT), owner of Zwentendorf, to move ahead with detailed plans for the sale of the unused plant. During 1986 Austria generated 70 percent of domestic electric power from hydroelectric stations and produced most of the balance from oil-fired power plants.

BELGIUM

Belgium's seven operating nuclear units, four at the Doel station near Antwerp and three at Tihange near Liege (Figure 6), accounted for approximately 67 percent of the country's total electric power output. The three oldest units, Tihange Unit 1 and Doel Units 1 and 2, all of which entered operation in 1975, underwent the country's first ten-year periodic inspections and therefore had abnormally long outages that reduced net overall nuclear plant efficiency for the year. Plans for an eighth unit (Doel Unit 5) are still awaiting approval. Under the arrangement between Belgium and France, Belgian companies are taking a 25-percent interest in Chooz Unit B1, a 1390-MWe plant under construction near the French-Belgian border, and also in Chooz Unit B2, which is planned. In return, French manufacturing companies are entitled to a 50-percent share in the construction of Doel Unit 5.

Synatom, the Belgian nuclear fuel supply company, reported no new uranium or enrichment contracts during 1986. The company manages an adequate forward inventory and takes deliveries of uranium from several producer countries. Concentrates are converted mainly in Europe and are enriched principally at Eurodif, of which Synatom is an 11.1-percent shareholder. In recent years Synatom eliminated large surpluses of Eurodif enrichment services through aggressive inventory management, so the company's fuel supply situation during 1986 was close to the desired level. During 1986 Synatom formally announced its decision not to revive the Eurochemic reprocessing facility at Dessel near the Dutch border, primarily due to a lack of interest from any

NUEXCO

EUROPE

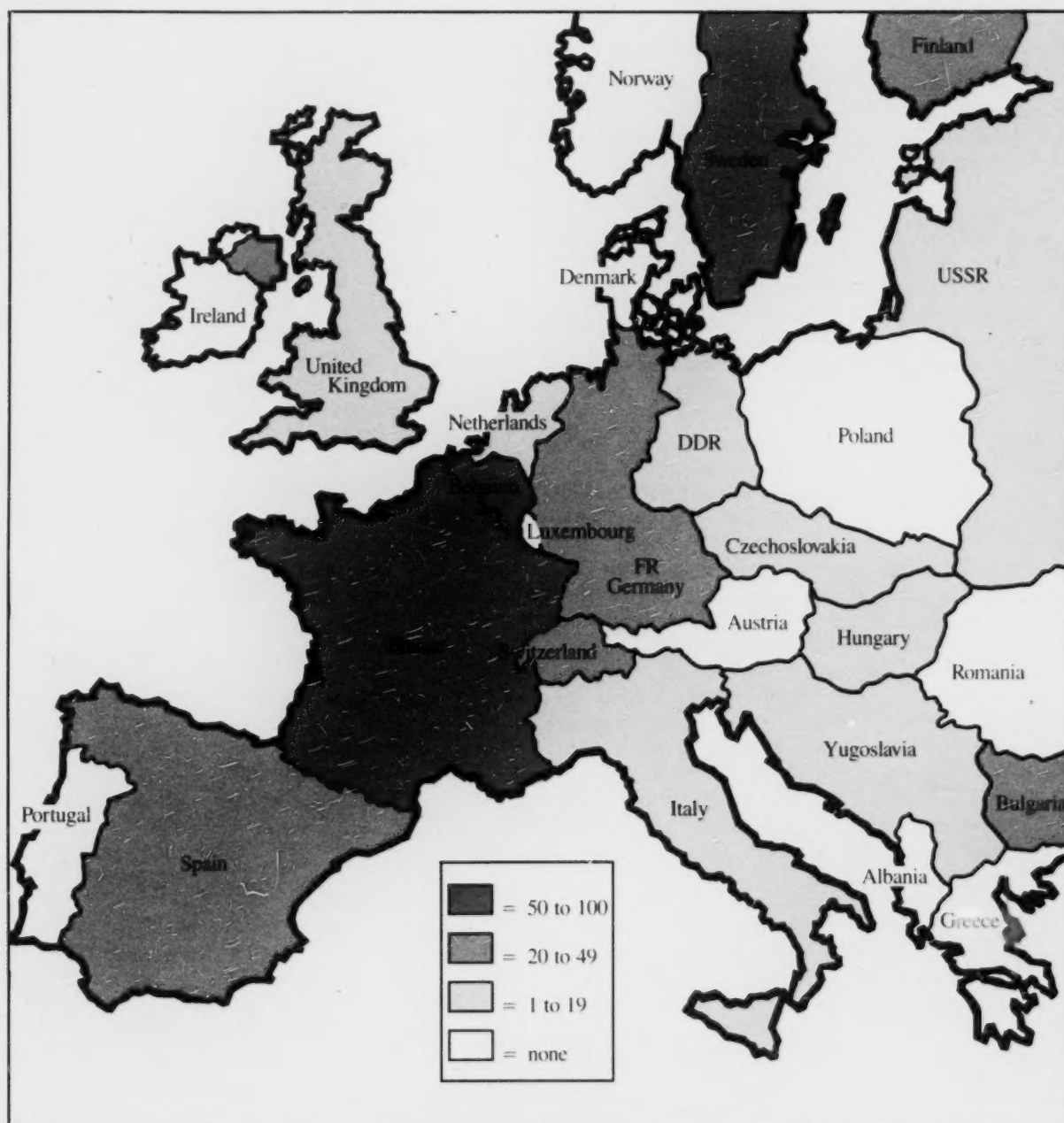


Figure 5
PERCENT OF TOTAL ELECTRICITY GENERATION FROM NUCLEAR
POWER STATIONS IN 1986

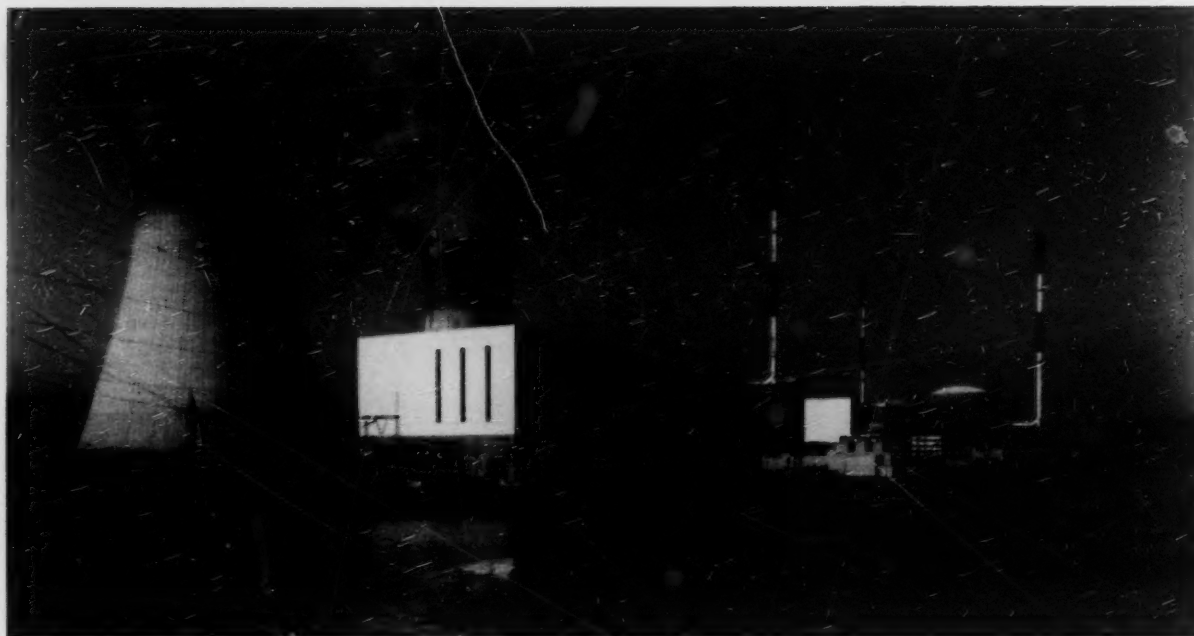


Figure 6. Tihange nuclear power station (2,750 MWe) on the Meuse River.

partner. Synatom had sought a 50-percent partnership with another European company to revive the project, and a major reason for the decision was the withdrawal of DWK (Deutsche Gesellschaft fuer Wiederaufarbeitung von Kernbrennstoffen mbH) in order to focus its activities on the plant under construction at Wackersdorf in West Germany.

FINLAND

The four Finnish nuclear units operated reliably during 1986, maintaining nuclear power's share of approximately 34 percent of the country's electric power production. Two of the units are owned and operated by a shareholder-owned utility consortium, Teollisuuden Voima Oy (TVO), and two are government-owned and operated by Imatran Voima Oy (IVO). During 1986 TVO continued to purchase uranium concentrates, conversion and fabrication services from western suppliers, while enrichment needs were handled by Technobexport in the USSR. Finnish electricity consumption increased by 1.2 percent in 1986, but plans for a fifth nuclear unit were postponed following the Chernobyl accident. Government approval for construction of a fifth unit is not expected in the near future.

FRANCE

Electricite de France (EdF) brought five new PWR units into commercial service during 1986, increasing the number of operating nuclear power units in France to 49, and the total net nuclear power capacity to approximately 44.8 GWe. In addition, the Superphenix Fast Breeder Reactor, a joint European project located north of Grenoble, entered commercial operation in the first quarter of 1986 and reached full rated capacity (1,200 MWe) in the fourth quarter. Thirteen PWRs are actively under construction, four of them scheduled for operation in 1987. In particular, during 1986 the last unit at the four-unit Paluel station (5,160 total MWe) in Normandy was completed and began full-power operation, and the first unit of the six-unit Cattenom station (7,590 total MWe) near the Luxembourg/FRG border entered commercial service. Figure 7 shows the locations of nuclear-power related facilities in France. Table 17 shows nuclear power's current role in the French electric power infrastructure and its contribution to total 1986 electricity production. Table 18 lists the nuclear power stations in France.

Net electricity exports from France to neighboring countries totalled 25.2 billion kwh during 1986, representing

NUEXCO

EUROPE

Figure 7
NUCLEAR PLANT SITES AND URANIUM PRODUCTION CENTERS IN FRANCE



Table 17

**ELECTRICITY GENERATING CAPACITY
AND 1986 ELECTRICITY PRODUCTION IN FRANCE**

Plant Type	Installed Generating Capacity		1986 Power Production	
	GWe	Percent	TWh	Percent
Nuclear	44.8	48	241	70
Fossil	24.6	27	40	12
Hydro	23.0	25	64	18
Total	92.4	100	345	100

Source: EdF

seven percent of total French electricity production (Table 19). Italy purchased the most electricity from France, taking advantage of relatively attractive prices when compared to costs of operating domestic fossil-fuel power plants. Swiss utilities also imported a substantial share of power from France. EdF exported a net 4.5 billion kwh to the UK during 1986 via the new cross-channel grid link. The first 1000-MWe capacity section of the cross-channel link became operational early in 1986 (Figure 8). The link will make possible increased sales of electricity from France to the UK, enabling the Central Electricity Generating Board (CEGB) to purchase electricity at relatively low rates. As French generating

Table 19

**1986 FRENCH ELECTRICITY IMPORTS
AND EXPORTS**

Country	Exports To France (GWh)	Imports From France (GWh)	French Export Balance (GWh)
Belgium	2,800	3,700	+ 900
FRG	2,600	2,000	- 600
Switzerland	1,000	7,700	+ 6,700
Italy	150	12,900	+ 12,750
Monaco	—	250	+ 250
Spain	1,100	1,800	+ 700
UK	150	4,650	+ 4,500
Total	7,800	33,000	+ 25,200

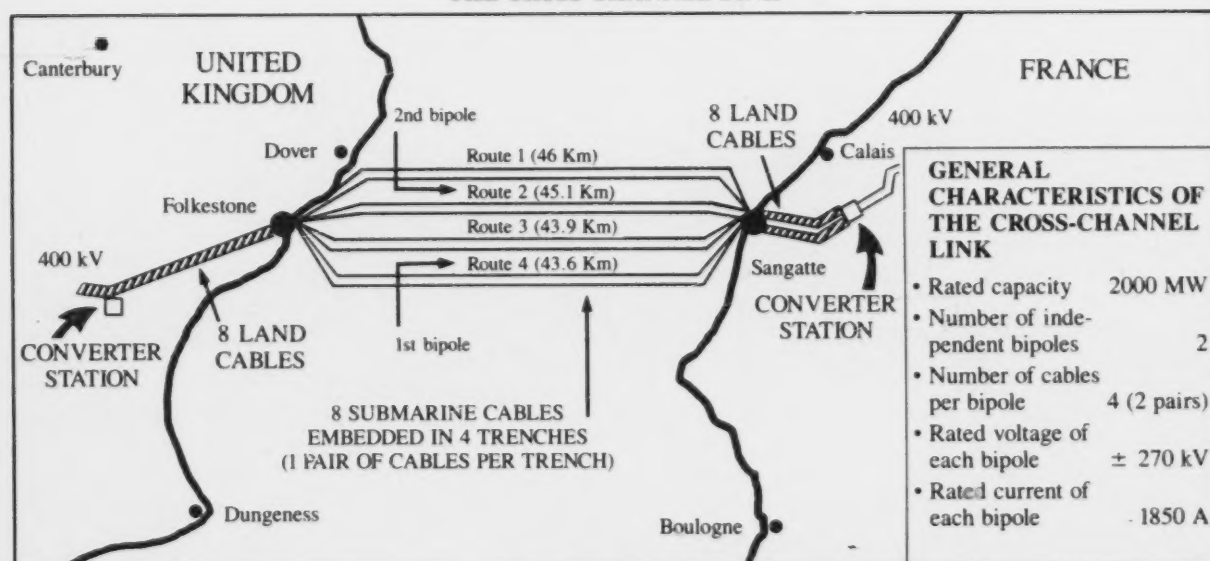
Source: EdF

capacity continues to expand at a rate faster than increases in French domestic power consumption, exports of French electricity to neighboring countries have become increasingly attractive.

EdF took delivery of uranium concentrates under existing long-term arrangements from a variety of sources during 1986, the largest suppliers being the French companies Cogema and Total Compagnie Miniere (TCM). Two new long-term contracts were negotiated during the year, one

Figure 8

THE CROSS-CHANNEL LINK



NUEXCO

EUROPE

Table 18
NUCLEAR POWER STATIONS IN FRANCE

Unit	Net MWe	Type	COD	Percent Complete
Belleville 1*	1275	PWR	1987	95
Belleville 2*	1275	PWR	1988	85
Blayais 1	910	PWR	1981	100
Blayais 2	910	PWR	1983	100
Blayais 3	910	PWR	1983	100
Blayais 4	910	PWR	1983	100
Bugey 1	540	GCR	1972	100
Bugey 2	920	PWR	1979	100
Bugey 3	920	PWR	1979	100
Bugey 4	900	PWR	1979	100
Bugey 5	900	PWR	1980	100
Cattenom 1	1265	PWR	1986	100
Cattenom 2*	1265	PWR	1987	95
Cattenom 3*	1265	PWR	1988	65
Cattenom 4*	1265	PWR	1990	45
Chinon A3	400	GCR	1967	100
Chinon B1	870	PWR	1984	100
Chinon B2	870	PWR	1984	100
Chinon B3	870	PWR	1986	100
Chinon B4*	870	PWR	1987	95
Chooz A ¹	310	PWR	1967	100
Chooz B1*	1400	PWR	1991	35
Cruas 1	880	PWR	1983	100
Cruas 2	880	PWR	1984	100
Cruas 3	880	PWR	1984	100
Cruas 4	880	PWR	1984	100
Dampierre 1	890	PWR	1980	100
Dampierre 2	890	PWR	1981	100
Dampierre 3	890	PWR	1981	100
Dampierre 4	890	PWR	1981	100
Fessenheim 1	880	PWR	1977	100
Fessenheim 2	880	PWR	1978	100
Flamanville 1	1290	PWR	1985	100
Flamanville 2	1290	PWR	1986	100

See footnotes next page.

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Table 18

NUCLEAR POWER STATIONS IN FRANCE (continued)

Unit	Net MWe	Type	COD	Percent Complete
Golfech 1*	1275	PWR	1990	55
Golfech 2*	1275	PWR	1993	25
Gravelines B1	910	PWR	1980	100
Gravelines B2	910	PWR	1980	100
Gravelines B3	910	PWR	1981	100
Gravelines B4	910	PWR	1981	100
Gravelines C5	910	PWR	1984	100
Gravelines C6	910	PWR	1985	100
Marcoule G2	40	GCR	1959	100
Phenix	233	LMFBR	1973	100
Nogent sur Seine 1*	1275	PWR	1987	90
Nogent sur Seine 2*	1275	PWR	1988	80
Paluel 1	1290	PWR	1985	100
Paluel 2	1290	PWR	1985	100
Paluel 3	1290	PWR	1985	100
Paluel 4	1290	PWR	1986	100
Penly 1*	1290	PWR	1989	60
Penly 2*	1290	PWR	1991	35
St. Alban 1	1300	PWR	1985	100
St. Alban 2	1300	PWR	1986	100
St. Laurent A1	460	GCR	1969	100
St. Laurent A2	515	GCR	1971	100
St. Laurent B1	880	PWR	1983	100
St. Laurent B2	880	PWR	1983	100
Superphénix ²	1200	LMFBR	1986	100
Tricastin 1	915	PWR	1980	100
Tricastin 2	915	PWR	1980	100
Tricastin 3	915	PWR	1981	100
Tricastin 4	915	PWR	1981	100
Total MWe ³	61,208			

Source: EDF

*Unit under construction.

¹Chooz Unit A is owned and operated by SENA (Société Nucléaire Franco-Belge des Ardennes), owned 50-percent each by EDF and the Belgian utilities.

²Superphénix is owned by NERSA, a European consortium of which the shareholders are EDF (51 percent), ENEL (33 percent), and SBK (16 percent). SBK is owned by RWE (FRG, 68.75 percent), SEP (Netherlands, 14.75 percent), Electronucléaire (Belgium, 14.75 percent), and CEGB (UK, 1.75 percent).

³Excluded from this list are Chinon A2, Marcoule G3, and Monts d'Arée, which are undergoing decommissioning, and Chooz B2, which has not yet been officially ordered.

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involving deliveries of Chinese-origin concentrates and one with a US producer. In addition, the Australian government lifted its two-year old ban on uranium exports to France in August 1986. As a result, EdF began receiving shipments of stockpiled Australian concentrates in accordance with its long-term contract with Queensland Mines Ltd. The French utility also purchased uranium in the spot market, taking advantage of the decline of prices as quoted in French francs.

Nuexco estimates that domestic French uranium production totaled approximately 7.7 million pounds U_3O_8 during 1986, and that all of that production was destined for use in France. TCM shut down its St. Pierre conventional uranium mill in June 1985 following the exhaustion of the St. Pierre ore deposit, and has increasingly relied on low-cost leaching operations at various mine sites. The company now operates only one conventional mill, at Mailhac-sur-Benaize in central France, but production from the company's domestic subsidiary (Total Compagnie Minière France) remains at approximately 1.5 million pounds U_3O_8 equivalent. TCM's domestic uranium supplies were augmented by its part ownership in Rossing Uranium Ltd., and the company is a participant in overseas uranium development programs in the USA and Australia.

Cogema continues to operate four conventional mills in France (Bessines, Lodeve, L'Ecarpière, and Langogne), producing the balance of domestic output, estimated at approximately 6.5 million pounds U_3O_8 . Cogema also controlled the uranium production operations of its subsidiaries Amok Ltd. at Cluff Lake, Saskatchewan (Canada), and Pathfinder Mines at Gas Hills and Shirley Basin, Wyoming (USA). As a leading participant in central African operations, Cogema managed production from Cominak, Somair and Comuf. In addition, Cogema took deliveries of substantial quantities of uranium under purchase arrangements with other mining operations in which it is not a shareholder. Nuexco estimates that Cogema produced or purchased approximately 20 percent of 1986 world uranium production. The company was also active as the operator and a principal shareholder of Cigar Lake Mining Company (CLMC), formed to exploit the world's richest known uranium deposit, located in Saskatchewan. CLMC currently anticipates commercial production from Cigar Lake in the early 1990s.

Nuexco estimates that 1986 production of UF_6 by Comurhex, and enriched uranium by Eurodif increased over 1985 levels of approximately 8.5 million kgU as UF_6 and 8.0 million SWU. Neither company has published production figures. Comurhex is a wholly French-owned company whose principal shareholders are Pechiney and Cogema. Effective ownership of Eurodif is shared by

Cogema (51.5 percent), Synatom of Belgium (11.1 percent), Enusa of Spain (11.1 percent), the government of Iran (10.0 percent), Agip Uranio of Italy (8.1 percent) and CNEA of Italy (8.1 percent). Cogema also operates two commercial reprocessing facilities in France, one at La Hague for LWR fuel, and one at Marcoule for GCR fuel, each having a capacity of 400 MTU per year. Expansion of the La Hague reprocessing facilities continued during 1986, consisting of two units each having 800 MTU per year capacity. Operation is scheduled for the first unit in 1989 and the second in 1992. Cogema and the French government are currently in negotiations with Japan Nuclear Fuel Services (JNFS) for a contract valued at 2.0 billion French francs, for the transfer from France to Japan of reprocessing technology and the construction of a commercial reprocessing plant in Japan during the 1990s.

FEDERAL REPUBLIC OF GERMANY

During 1986 two nuclear units began commercial operation in the FRG, the THTR 300 in North-Rhine Westphalia, and Brokdorf, a 1,290-MWe PWR located in the northern part of the country, near Hamburg. RWE's Muelheim-Kaerlich plant, a 1,227-MWe PWR built by the Brown Boveri Group, successfully underwent pre-commercial testing during 1986 but in October 1986 was prevented from commercial operation by a lawsuit that challenged licensing of the plant's cooling tower. Three units remain under construction in the FRG, all large Kraftwerk Union (KWU) PWRs that are part of a standardized reactor line. Two of these units (Isar Unit 2 and Emsland) are likely to begin operation ahead of schedule in 1988, and one (GKN Unit 2) is currently scheduled for completion in 1989. Operation of the completed Kalkar Fast Breeder Reactor, a joint European project, continues to be delayed by the responsible state Minister of Economic Affairs in North Rhine Westphalia. Table 20 lists the nuclear power units in the FRG and Figure 9 shows utility ownership in those units.

Electricity production from nuclear power stations in the FRG declined slightly during 1986 due to lower capacity use at the existing stations. The average plant capacity factor declined to 79 percent, from 85 percent the previous year. Nevertheless, three units, Grohnde, Unterweser and Philippsburg Unit 2, each produced over 10.4 billion kwh during 1986. The use of fuel sources varies among regions and is affected by the proximity of coal or lignite mines. RWE, the FRG's largest utility, still produces 80 percent of its electricity from lignite and coal plants in the industrial western part of the country, while most of the other major utilities now

Table 20

NUCLEAR POWER UNITS IN THE FEDERAL REPUBLIC OF GERMANY

Lead Utility and Fuel Buyer	Unit	MWe	Type	COD	Percent Complete
BW/EVS	Philippsburg 1	864	BWR	1980	100
	Philippsburg 2	1268	PWR	1985	100
BAG	Grafenrheinfeld	1235	PWR	1982	100
	Isar 1	870	BWR	1979	100
	Isar 2*	1285	PWR	1988	80
GKN	GKN 1	795	PWR	1976	100
	GKN 2*	1230	PWR	1989	60
HEW	Brunsbüttel	771	BWR	1977	100
	Krümmel	1260	BWR	1984	100
KWO	Obrigheim 1	328	PWR	1969	100
PE	Würgassen	640	BWR	1972	100
	Stade	630	PWR	1972	100
	Unterweser	1230	PWR	1979	100
	Grohnde	1290	PWR	1985	100
	Brokdorf	1290	PWR	1987	100
RWE	Biblis A	1146	PWR	1975	100
	Biblis B	1240	PWR	1977	100
	Gundremmingen B	1244	BWR	1984	100
	Gundremmingen C	1244	BWR	1985	100
	Mülheim-Kaerlich	1227	PWR	1987	100
SBK	Kalkar*	295	LMFBR	1987	95
VEW	THTR 300	296	HTR	1986	100
	Emsland*	1242	PWR	1988	75
Total		22,920			

*Unit under construction

BW = Badenwerk AG

BAG = Bayernwerk AG

EVS = Energieversorgung Schwaben AG

GKN = Gemeinschaftskernkraftwerk Neckar GmbH

HEW = Hamburgische Elektrizitätswerke AG

KWO = Kernkraftwerk Obrigheim GmbH

PE = Preussen Elektra AG

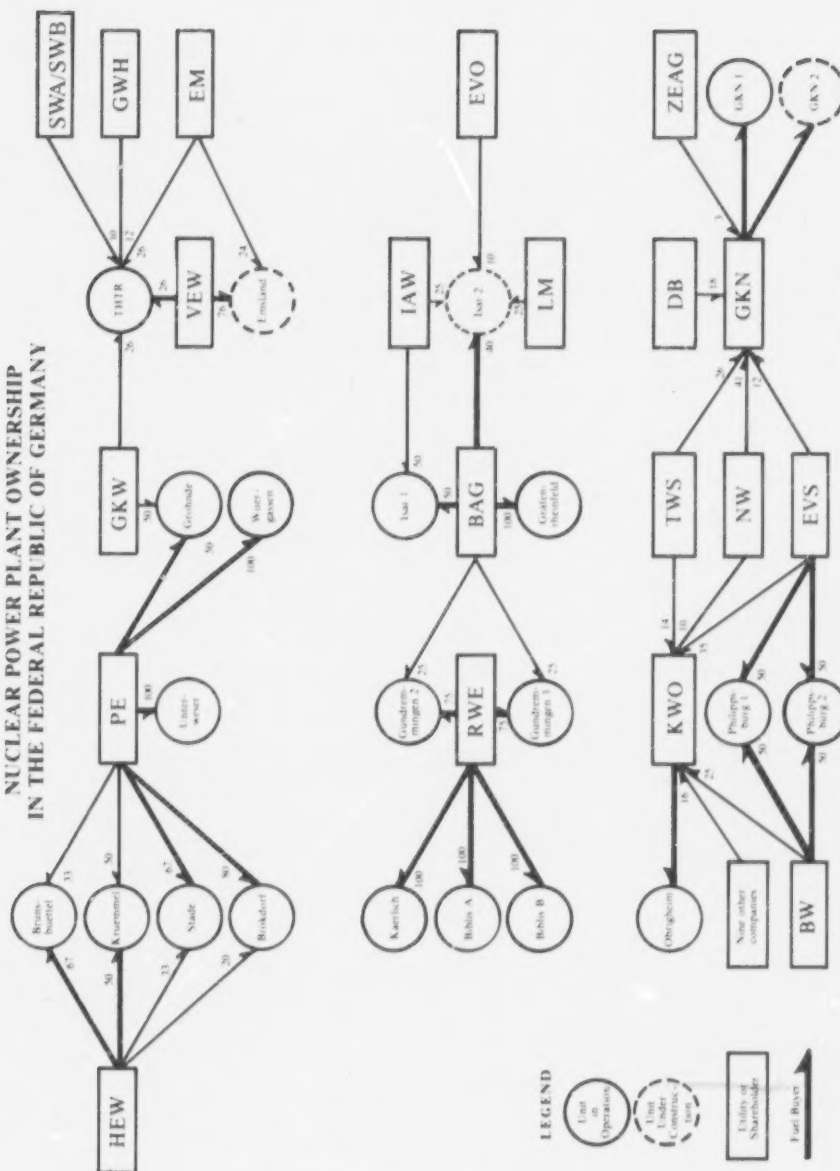
RWE = Rheinisch-Westfälisches Elektrizitätswerk AG

SBK = Schnell-Breuter Kernkraftwerksgesellschaft mbH

VEW = Vereinigte Elektrizitätswerke Westfalen AG

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Figure 9
NUCLEAR POWER PLANT OWNERSHIP
IN THE FEDERAL REPUBLIC OF GERMANY



BAG	Bayerwerk AG	GKW	Gesellschaft für Kernkraftwerke Wuppertal GmbH	PE	Preussag AG
BW	Badenwerk AG	UStW	Umsatzsteuerwerk Hamburg GmbH	RWE	Rheinisch-Westfälisches Elektrizitätswerk AG
DB	Deutsche Bundesbahn	HEW	Hamburgische Elektrizitätswerke AG	SWA	Stadtwerke Aachen AG
EM	Elektronik AG	IAW	Isar-Atomkraftwerk AG	SWB	Stadtwerke Bonn AG
EVO	Energieversorgung Ostbayern AG	KWO	Kernkraftwerk Obrigheim GmbH	TWS	Technische Werke der Stadt Stuttgart AG
EVS	Energieversorgung Schwaben AG	LM	Landeshausplatz München	VEW	Vereinigte Elektrizitätswerke Westfalen AG
GKN	Gesellschaft für Kernkraftwerke Neckar GmbH	NW	Niederrheinische Elektrizitätswerke AG	ZAG	Zentralwerk Lauffen Elektrizitätswerk Heidelberg AG

use nuclear stations for over 50 percent of generation needs (Figure 10).

The Chernobyl accident had a serious negative effect on public perceptions of nuclear energy in the FRG. Following that event, politicians associated with the Social Democrat (SPD) and Green parties made anti-nuclear rhetoric a major part of their 1986 campaigns. However, the ruling federal coalition government (Christian Democratic Union/Christian Social Union/Free Democratic Party) retained power in key state elections during 1986, and in federal elections early in 1987, despite its support for nuclear power. The coalition benefited from the economic prosperity in the FRG in recent years, the result of strong industrial performance. The coalition's victory has relieved anti-nuclear pressure, at least temporarily. However, problems with specific nuclear-related projects are likely to persist at the local level, particularly in those states where the SPD and Green parties have broad support, such as in North Rhine Westphalia and Hessen. It

will be very difficult to gain approval for construction of any additional nuclear units in the FRG.

Because of the absence of significant domestic uranium deposits, utilities in the FRG contract abroad for supplies, or procure supplies through German uranium companies having direct interests in overseas mining projects (Figure 11). The particular supply sources used by each utility vary widely, but together German companies took uranium deliveries during 1986 from every significant supplier country, including the People's Republic of China (PRC). Two utilities made substantial spot purchases during 1986 and one utility was known to have renewed a long-term contract with an African supplier. In general, however, the utilities' supplies are covered by substantial inventories and existing long-term contract arrangements, and new market activity has recently been limited. On the other hand, the main German uranium companies, including Uranerz Exploration and Mining Ltd.

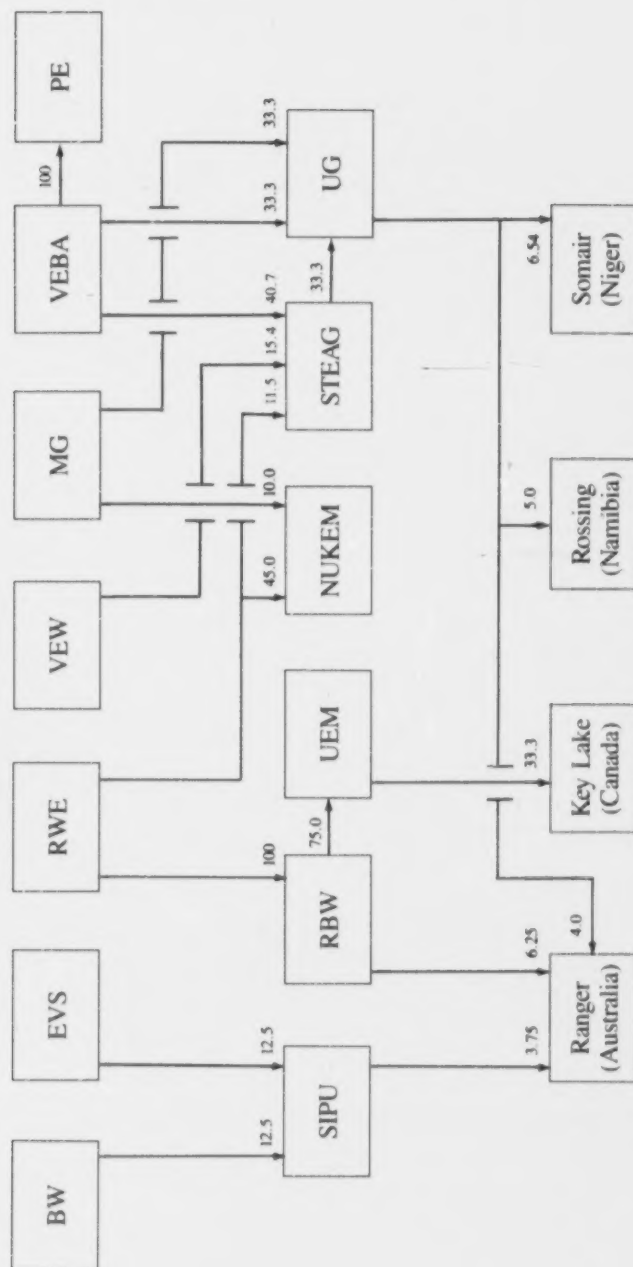


Figure 10. Actual Nuclear Energy share of principal utilities within the Federal Republic of Germany (FRG).

Source — Nuclear Europe

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Figure II
GERMAN OWNERSHIP IN ACTIVE
URANIUM PRODUCTION AND TRADING OPERATIONS



BW	— Badenwerk AG	SIPU	— Saarberg Interplan Uran GmbH
EVS	— Energieversorgung Schwaben AG	STEAG	— Sicag AG
MG	— Metallgesellschaft AG	UEM	— Uranerz Exploration & Mining Co.
NUKEM	— Nukem GmbH	UG	— Urangesellschaft mbH
PE	— PreussenElektra AG	VEBA	— Veba AG
RBW	— Rheinische Braunkohlenwerke AG	VEW	— Vereinigte Elektrizitätswerk Westfalen AG
RWE	— Rheinisch-Westfälisches Elektrizitätswerk AG		

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(UEM), Steag Kernenergie and Urangesellschaft, participated actively in the international spot and long-term markets. The FRG utilities' conversion requirements are provided by all of the primary converters, depending on concentrate supply location and other considerations. Urenco has become the principal supplier of enrichment services to the FRG, followed by Techsnabexport, DOE and Eurodif. German companies own a one-third share in Urenco, and expansion of capacity is underway at Urenco's German plant, beyond the current level of 200,000 SWU per year.

Kraftwerk Union (KWU) increased its presence in the US nuclear fuel market by acquiring Exxon Nuclear in the second half of 1986. The activities of Exxon Nuclear, renamed Advanced Nuclear Fuels, are expected to continue unchanged, but some future consolidation with KWU's partly-owned fuel fabrication subsidiaries RBU (Reaktor Brennelement Union) and Alkem is likely. Alkem's activities are specifically directed toward the fabrication of FBR fuel and mixed oxide (MOX) assemblies, which have provided some use for the plutonium stocks acquired through reprocessing contracts with Cogema and BNFL. Construction on the domestic reprocessing facility at Wackersdorf, which began in December 1985, continued smoothly during 1986, in spite of protests aimed at stopping construction of the plant. In October 1986, DWK applied for the license needed for the second phase of construction. Research into final disposal of spent fuel in deep geological salt formations continues in the FRG. The first shaft at Gorleben in the northeast part of the country was started in September 1986, in a salt dome formation; completion of both the first and second evaluation shafts is expected by the end of 1989.

ITALY

The Italian state utility ENEL operated three nuclear units during 1986, Latina (150-MWe GCR), Trino Vercellese (260-MWe PWR) and Caorso (875-MWe BWR). An additional five units were under construction; Cirene, a 40-MWe heavy-water moderated plant, the two-unit BWR station at Montalto di Castro currently scheduled for completion in 1990, and an additional two units in the early stages of construction at Trino Vercellese in Piedmont. ENEL's nuclear power plans have been delayed repeatedly over the past several years, in large part because of public opposition. That opposition intensified following the Chernobyl accident in April 1986 and has cast some doubt on the future of the units under construction.

A National Energy Conference was held in late February 1987 to discuss future energy policy in Italy. The findings of

the Conference will be considered by the Italian Parliament. In addition, a public referendum on the use of nuclear energy in Italy is scheduled to be held in June 1987. Currently the Italian government's ruling coalition, comprised of centrist and moderately conservative parties, supports the completion of those nuclear units under construction. The three operating units generated between 5 and 6 percent of Italy's total electricity production in 1986, while Italy imported approximately 12 percent of its electric power needs, principally from France.

ENEL owns a substantial inventory of uranium in all forms and therefore has not been an active buyer in either the spot or long-term markets in recent years. If the units now under construction are completed, the utility could have unfilled requirements in the 1990s. Fabricazioni Nucleari (FN), a member of the ENI Energy and Chemicals Group, designs and fabricates nuclear fuel in Italy for both PWRs and BWRs, under Westinghouse and General Electric licenses. FN's sister company, Agip Uranio SpA has successfully disposed of excess uranium and enrichment inventories during recent years.

THE NETHERLANDS

Early in 1986 the Dutch government approved plans for construction of a new two-unit nuclear power station in the Netherlands, but the decision to proceed was halted immediately after the Chernobyl accident. Dutch parliamentary elections took place in May 1986; because the Chernobyl accident had occurred just a few weeks prior to the vote, the ruling coalition moved quickly to try to minimize the political problems caused by its association with nuclear energy. In the elections the coalition lost support but retained control of the government by a margin of six parliamentary seats. Currently a nuclear power evaluation commission, under the direction of the Ministry of Environmental Affairs, is conducting an investigation of nuclear power issues. No decision on the future of the planned units will be taken by the government before the commission's report is issued. The Dutch utilities do not expect the report to be issued for several months; once it is issued, the ministers must make a policy statement on nuclear energy, and the Parliament must vote on the subject. If this process can be completed by the end of 1987 in a way that reflects favorably on nuclear energy, there is a possibility that the original plan for a 2,000-MWe station may be fulfilled. However, if the decision by Parliament is negative or is delayed further, the utilities are likely to begin constructing coal-fired stations needed to fulfill future capacity needs. Currently the Netherlands generates the majority of its domestic electric power from natural gas,

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obtained from gas fields in the northern part of Holland and in the North Sea, and also from coal.

Two nuclear units, Borssele (445-MWe) and Dodewaard (55-MWe), are in operation in the Netherlands. Borssele recently underwent a special safety investigation by the OSART (Operational Safety Review Team) commission of the International Atomic Energy Agency (IAEA). No safety problems were discovered, although some suggestions were noted. Dodewaard will undergo a similar investigation during 1987. In recent years natural uranium requirements have been supplied from inventories and spot purchases rather than from long-term contract arrangements, while enrichment has been supplied principally by DOE for Borssele, and by Urenco for Dodewaard. Enrichment needs for both units will be covered by Urenco beginning in 1988-89.

PORTUGAL

Nuexco estimates that production of U_3O_8 concentrates by ENU (Empresa Nacional de Uranio) at the Urgeirica mill amounted to approximately 300,000 pounds U_3O_8 in 1986, about the same as in recent years. ENU has successfully marketed its material to European and US companies. No

plans for substantial changes in ENU's production activities have been announced.

SPAIN

Nuclear energy's contribution to total Spanish electricity generation grew by 8 percent during 1986 to 31 percent (Table 21), while total generation from all other sources declined. Nuclear power replaced hydroelectric as the second greatest source of electricity, after hard coal. Currently eight nuclear units are in commercial operation in Spain and two are under active construction (Table 22); construction on four additional units has been deferred by the Spanish government under its 1984 energy plan. During 1986, considerable progress was made on the two units actively under construction (Vandellos Unit 2 and Trillo Unit 1) and both units currently are scheduled for fuel loading in 1987 and commercial operation in the first half of 1988.

The expected addition to the Spanish grid of Vandellos Unit 2 and Trillo Unit 1 will complete the current energy plan; the government will then be in a position to reevaluate the status of the four units that have been deferred. Such a reevaluation is anticipated near the end of 1988. The future of



Figure 13. Spain's Almaraz Nuclear Power Plant

Table 22
NUCLEAR POWER UNITS IN SPAIN

Unit	Owners	MWe	Type	COD
Operating				
Jose Cabrera ¹	UE	153	PWR	1969
Garona	ISA/EV	440	BWR	1971
Vandellos 1	Fecsa/Enher ² /HC ³ /EdF	480	GCR	1972
Almaraz 1	UE/ISA/HE/SE	930	PWR	1981
Almaraz 2	UE/ISA/HE/SE	930	PWR	1983
Asco 1	Fecsa/Endesa	887	PWR	1984
Asco 2	Fecsa/Enher/HC/Segre ⁴	887	PWR	1985
Cofrentes	HE	975	BWR	1985
TOTAL		5,682		
Under Construction				
Trillo 1	UE/ISA/HCO	997	PWR	1988
Vandellos 2	Enher/HC/Endesa	982	PWR	1988
TOTAL		7,661		
Indefinitely Deferred				Percent Complete
Lemoniz 1	ISA	900	PWR	95
Lemoniz 2	ISA	900	PWR	60
Valdecaballeros 1	HE/SE	975	BWR	60
Valdecaballeros 2	HE/SE	975	BWR	45
TOTAL		3,750		

¹ Also known as Zorita.

² Endesa purchased 100% of the capital of Enher in December 1985; Enher retains independent operations.

³ HE purchased 100% of the capital of HC in December 1985; HC retains independent operations.

⁴ Fecsa purchased 100% of the capital of Segre prior to December 1985; Segre retains independent operations.

EdF = Electricite de France.

Endesa = Empresa Nacional de Electricidad SA.

Enher = Empresa Nacional Hidroelectrica Riborganza SA.

EV = Electricidad de Viesgo SA.

Fecsa = Fuerzas Electricas de Cataluna SA.

HC = Hidroelectrica de Cataluna SA.

HCO = Hidroelectrica de Cantabrico SA.

HE = Hidroelectrica Española SA.

ISA = Iberduero SA.

SE = Compania Sevillana de Electricidad SA.

Segre = Fuerzas Electricas del Segre SA.

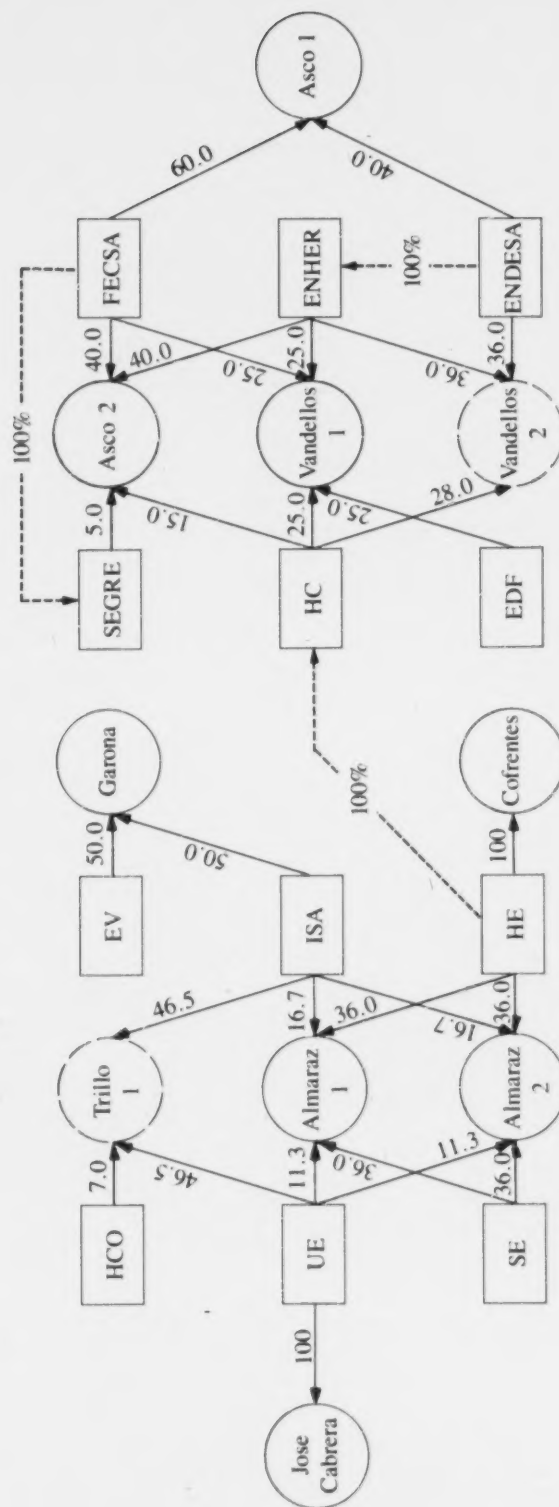
UE = Union Electrica-Fenosa SA.

NUEXCO

EUROPE

Figure 12

UTILITY OWNERSHIP OF NUCLEAR POWER UNITS IN SPAIN



HCO = Hidroeléctrica de Cantabrico SA.
HE = Hidroeléctrica Española SA.
ISA = Iberduero SA.
SE = Compania Sevillana de Electricidad SA.
SEGRE = Fuerzas Electricas del Segre SA.
UE = Union Electrica-Fenosa SA.

Note: ENUSA is the fuel buyer for all Spanish units.

EdF = Electricité de France.
ENDESA = Empresa Nacional de Electricidad SA
ENHER = Empresa Nacional Hidroeléctrica
Riborganza SA.
EV = Electricidad de Viesgo SA.
FECSA = Fuerzas Electricas de Cataluña SA.
HC = Hidroeléctrica de Cataluña SA.

Unit in
Commercial
Operation

Unit Under
Construction

EUROPE

the deferred units, particularly that of the Lemoniz station located in the Basque region, will depend on political as well as economic questions. Under the current government energy plan, 3.9 percent of national electricity rates go toward supporting the deferred units. All of the main regional utilities, as well as the state utility Endesa, own shares in nuclear units following a government reorganization of utility holdings completed during 1985. Figure 12 shows utility ownership in the ten Spanish units that are part of the current energy plan. Figure 13 shows the Almaraz nuclear power station in western Spain.

Table 21

COMPARISON BY SOURCE OF 1985 AND 1986
SPANISH ELECTRICITY PRODUCTION¹

Electricity Source	1985 (GWh)	1986 (GWh)	1986 Percent of Total
Coal	53,384	53,338	44
Nuclear	28,044	37,457	31
Hydro	31,717	25,979	21
Natural Gas and other	3,024	2,347	2
Fuel Oil	3,857	2,133	2
Total	120,026	121,254	100

¹Does not include Balearic and Canary Islands, or Spanish possessions in northern Africa.

The government-owned uranium company Enusa (Empresa Nacional de Uranio SA) has managed an adequate inventory and long-term fuel supplies over the past few years. During 1986, Enusa concentrated on optimizing the forms and locations of its supplies and did not actively seek additional material. Enusa's long-term strategy for natural uranium procurement is to decrease dependence on foreign source material by increasing domestic production, currently rated at approximately 500,000 pounds U₃O₈ per year, to 2.5 million pounds per year. Enusa also owns shares in African mining operations. For enrichment, Enusa takes deliveries primarily from DOE, under a USEC covering several of its units, and from Eurodif, of which it is an 11.1-percent shareholder.

SWEDEN

Sweden's twelve nuclear units (Table 23) generated 52 percent of the country's total electric power during 1986. The average capacity factor of the 12 units was 80.6 percent, with Oskarshamn Unit 3 performing at 90.4 percent. Average availability factor of all units was 87.1 percent; the Forsmark

Units 1 and 2 and Oskarshamn all operated at availability factors above 92 percent. 1986 was the first full year in which all of the Swedish units were in operation; no other units are now under construction or planned.

Following the Chernobyl accident there was considerable discussion in Sweden regarding possibly accelerating the nation's withdrawal from nuclear energy. This withdrawal is currently scheduled for the year 2010. Environmentalists also questioned the safety status of the country's older nuclear plants. The ruling Social Democrat Party introduced a bill to Parliament outlawing activities preparatory to planning or construction of additional nuclear power plants. However, the various discussions have not presented serious problems for the Swedish utilities, and the importance of the nuclear units in Sweden's electric power infrastructure has effectively weakened the anti-nuclear movement's influence. In January 1987, nine months after the Chernobyl accident, a public opinion poll taken in Sweden showed attitudes toward nuclear power to be about the same as in January 1985 and early April 1986.

All of the Swedish utilities were active to some degree in the uranium and enrichment markets during 1986, reflecting their moderate inventory levels compared to most other European utilities. One utility purchased uranium on the spot market in all forms, while the other two made smaller spot purchases. The three utilities follow a *de facto* policy of purchasing non-southern African uranium and have most of their natural uranium supply arrangements with Canadian and Australian producers. Enrichment requirements in the medium term will be filled by contracts with all of the primary enrichers as well as secondary suppliers.

Sweden's centralized intermediate-term spent fuel storage facility (CLAB) operated successfully during 1986. The facility is located at Simpevarp, adjacent to the Oskarshamn power station on Sweden's east coast. CLAB is owned by SKB (Svensk Karnbränslehantering AB), the Swedish waste-management company, and is operated by OKG AB, the owner of the Oskarshamn station. After five years of construction, the CLAB facility entered operation in July 1985. CLAB is designed to store 3,000 MTU, and can be expanded to hold up to 9,000 MTU if required, the equivalent of all spent fuel from Sweden's nuclear power plants over 30 years of operation. CLAB is built 30 meters below sea level and is approximately 120 meters long, 21 meters wide, and 27 meters high. Spent fuel assemblies are stored in pools of water.

Construction of the Final Repository for Reactor Waste (SFR), intended for low-level and intermediate-level radioactive waste, proceeded on schedule. Completion of the facility is expected in 1988. SFR is located under the sea floor, adjacent to the Forsmark power station north of Stockholm.

EUROPE

Table 23
COMMERCIAL NUCLEAR PLANTS IN SWEDEN

Unit	Utility	MWe	Type	COD ¹
Oskarshamn 1	OKG ²	440	BWR	Feb 1972
Oskarshamn 2	OKG	595	BWR	Dec 1974
Oskarshamn 3	OKG	1050	BWR	Aug 1985
Barseback 1	Sydskraft	570	BWR	Jul 1975
Barseback 2	Sydskraft	570	BWR	Jul 1977
Ringhals 1	SSPB ³	750	BWR	Feb 1976
Ringhals 2	SSPB	800	PWR	May 1975
Ringhals 3	SSPB	915	PWR	Apr 1981
Ringhals 4	SSPB	915	PWR	Nov 1983
Forsmark 1	FKA ⁴	900	BWR	Dec 1980
Forsmark 2	FKA	900	BWR	Jul 1981
Forsmark 3	FKA	1050	BWR	Aug 1985
Total		9,455		

¹Actual or expected Commercial Operation Date.

²Sydskraft AB owns 38 percent of OKG.

³SSPB = Swedish State Power Board.

⁴FKA = Forsmarks Kraftsgrupp AB, SSPB owns 74.5 percent of FKA and is the operator and fuel purchaser for the plant.

SWITZERLAND

Switzerland's five operating nuclear units (Table 24) accounted for approximately 38 percent of total electricity generation during 1986, the same percentage as 1985. No changes in installed capacity have occurred since the last unit entered service in 1984 (Leibstadt). Plans for construction of a sixth unit at Kaiseraugst near Basel were stalled again following the Chernobyl accident in April 1986. A vote on energy policy held late in 1986 in the Swiss Parliament confirmed the national consensus that nuclear energy cannot be phased out rapidly in Switzerland, and a formal decision on any phase-out has been deferred until a new national energy study is completed near the end of 1987. The owners of the Kaiseraugst project, including several Swiss companies and two West German utilities, have postponed selection of a primary supplier for the station until a political decision on the future of nuclear energy in Switzerland is finally made.

The Swiss federal government signed bilateral nuclear fuel agreements with the Australian and Chinese governments during 1986. Neither agreement will be effective until ratified by the Swiss Parliament, but such ratification is expected during 1987. Currently the utilities' uranium requirements are amply met by US and African sources. Three of the Swiss utilities are participants in mining operations in the Arizona Strip in the southwestern USA. Enrichment requirements are

covered primarily by contracts with European suppliers, although one utility has a long-term DOE contract. None of the utilities were active as a buyer in the natural uranium spot market during 1986.

Table 24

NUCLEAR POWER UNITS IN SWITZERLAND

Unit	Utility	MWe	Type	COD ¹
Operating				
Beznau 1	NOK ²	350	PWR	Dec 1969
Beznau 2	NOK	350	PWR	Mar 1972
Muehleberg	BKW ³	320	BWR	Oct 1972
Goesgen	KKG ⁴	920	PWR	Nov 1979
Leibstadt	KKL ⁵	925	BWR	Dec 1984
Planned				
Kaiseraugst	KWK ⁶	925	BWR	indefinite
Graben	KWG ⁷	1140	BWR	indefinite

¹Actual or expected Commercial Operation Date.

²NOK = Nordostschweizerische Kraftwerk AG.

³BKW = Bernische Kraftwerk AG.

⁴KKG = Kernkraftwerk Goesgen Daeniken AG.

⁵KKL = Kernkraftwerk Leibstadt AG.

⁶KWK = Kernkraftwerk Kaiseraugst AG.

⁷KWG = Kernkraftwerk Graben AG.

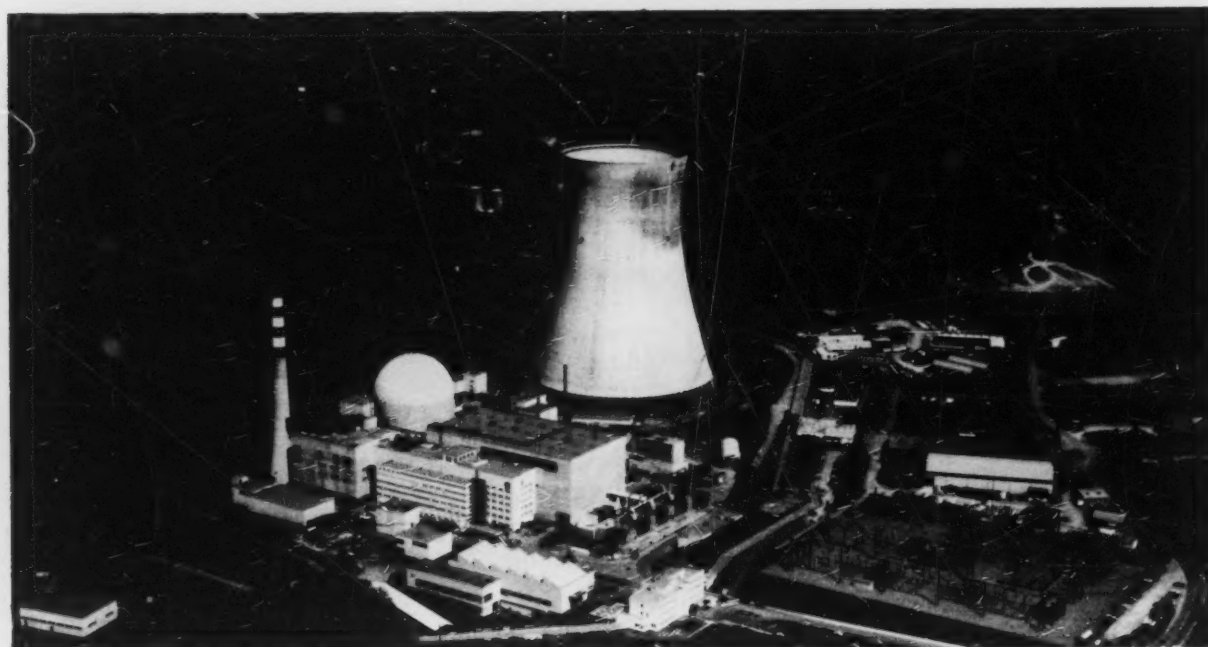


Figure 14. Leibstadt Nuclear Power Plant

EUROPE

UNITED KINGDOM

At the beginning of 1986, Dungeness Unit B2 (600-MWe AGR) entered commercial service, increasing the number of operating AGR units in Britain to 10 and the total installed nuclear generating capacity to 10.3 GWe (Table 25). Four AGRs are under construction, two at the Heysham station in northwest England and two at Torness Point in southeast Scotland (Figure 15). All of them currently are scheduled for commercial operation within the next eighteen months. In addition, the Central Electricity Generating Board (CEGB) continues development work on the planned Sizewell B 1,155-MWe PWR, to be sited adjacent to two GCRs on England's east coast. Following a two-year public inquiry on the proposed project that began in 1982, and a further two years of report preparation, the Sizewell inspector delivered his report on the project to the Energy Secretary in December 1986. The report's contents, which are generally favorable toward construction of the Sizewell plant, were published in January 1987. Formal approval for CEGB to proceed with Sizewell was received on March 12, 1987 following a Parliamentary debate. This marked the beginning of the construction phase, with commissioning planned for 1995.

The principal uranium supply company for the UK is the British Civil Uranium Procurement Organization (BCUPO). Much of the UF₆ conversion requirements for British plants are handled by state-owned British Nuclear Fuels Plc (BNFL), which is one-third owner of Urenco, the centrifuge enrichment consortium. BNFL's conversion capacity is rated at 9,500 MTU as UF₆ per year and the company supplies a significant portion of conversion services for the European and Japanese markets. BNFL is also a one-third owner of

Urenco, the enrichment consortium owned equally by UK, Dutch and West German interests (Figure 16); Urenco operates one enrichment plant at Capenhurst in the English Midlands. Urenco supplies the majority of enrichment needs for British AGR fuel, while BNFL handles all of the fuel fabrication for the British plants.

BNFL also owns and operates the UK's commercial reprocessing facilities at Sellafield in northwestern England. Because of Britain's high degree of self-sufficiency in the nuclear fuel cycle, the only significant fuel import activities involve the purchase of natural uranium concentrates. After relying for several years on Canadian and African producers for U₃O₈ supplies, BCUPO concluded two long-term contracts with US producers in 1985, and in 1987 completed negotiation of a long-term contract to buy U₃O₈ from the Olympic Dam project in Australia. British Petroleum (BP), the UK oil company, is a 49-percent shareholder in Olympic Dam.

YUGOSLAVIA

Yugoslavia's Krsko nuclear power unit, a 615-MWe PWR which entered commercial operation in December 1981, is jointly owned by the Slovenian utility Savske Elektrane and the Croatian utility Elektroprivreda. The Yugoslavian utilities are apparently interested in a further expansion of the country's nuclear power program, but the timing of such an expansion appears to be uncertain since the Chernobyl accident. Uranium for Krsko was supplied from a combination of domestic production and spot market purchases during 1986, while enrichment was provided by DOE under a long-term contract.

Figure 15
NUCLEAR POWER FACILITIES IN THE UNITED KINGDOM



NUEXCO

EUROPE

Table 25

COMMERCIAL NUCLEAR UNITS IN THE UNITED KINGDOM

Station/Unit	MWe net per Reactor	Type	Operating Entity	COD	Percent Complete
Calder Hall 1, 2, 3, 4	50	GCR	BNFL ¹	1956	100
Chapel Cross 1, 2, 3, 4	50	GCR	BNFL	1958	100
Berkeley 1, 2	138	GCR	CEGB ²	1962	100
Bradwell 1, 2	123	GCR	CEGB	1962	100
Hunterston A1, 2	150	GCR	SSEB ³	1964	100
Trawsfynydd 1, 2	195	GCR	CEGB	1965	100
Hinkley Point 1, 2	215	GCR	CEGB	1965	100
Dungeness A1, 2	212	GCR	CEGB	1965	100
Sizewell A1, 2	210	GCR	CEGB	1966	100
Oldbury 1, 2	217	GCR	CEGB	1968	100
Winfrith	92	HWLWR	UKAEA ⁴	1968	100
Wylfa 1, 2	420	GCR	CEGB	1971	100
Dounreay	250	LMFBR	UKAEA	1976	100
Hinkley Point B1	625	AGR	CEGB	1976	100
Hinkley Point B2	625	AGR	CEGB	1977	100
Hunterston B1	625	AGR	SSEB	1976	100
Hunterston B2	625	AGR	SSEB	1977	100
Dungeness B1	600	AGR	CEGB	1984	100
Heysham A1	625	AGR	CEGB	1984	100
Heysham A2	625	AGR	CEGB	1985	100
Hartlepool A1	625	AGR	CEGB	1984	100
Hartlepool A2	625	AGR	CEGB	1985	100
Dungeness B2	600	AGR	CEGB	1986	100
Total MWe in Operation	10,282				
Heysham B1*	625	AGR	CEGB	1987	100
Heysham B2*	625	AGR	CEGB	1988	95
Torness Point 1*	625	AGR	SSEB	1987	100
Torness Point 2*	625	AGR	SSEB	1988	95
Sizewell B1**	1155	PWR	CEGB	1995	0
TOTAL MWe	13,937				

*Unit under construction.

**Unit on order and undergoing licensing.

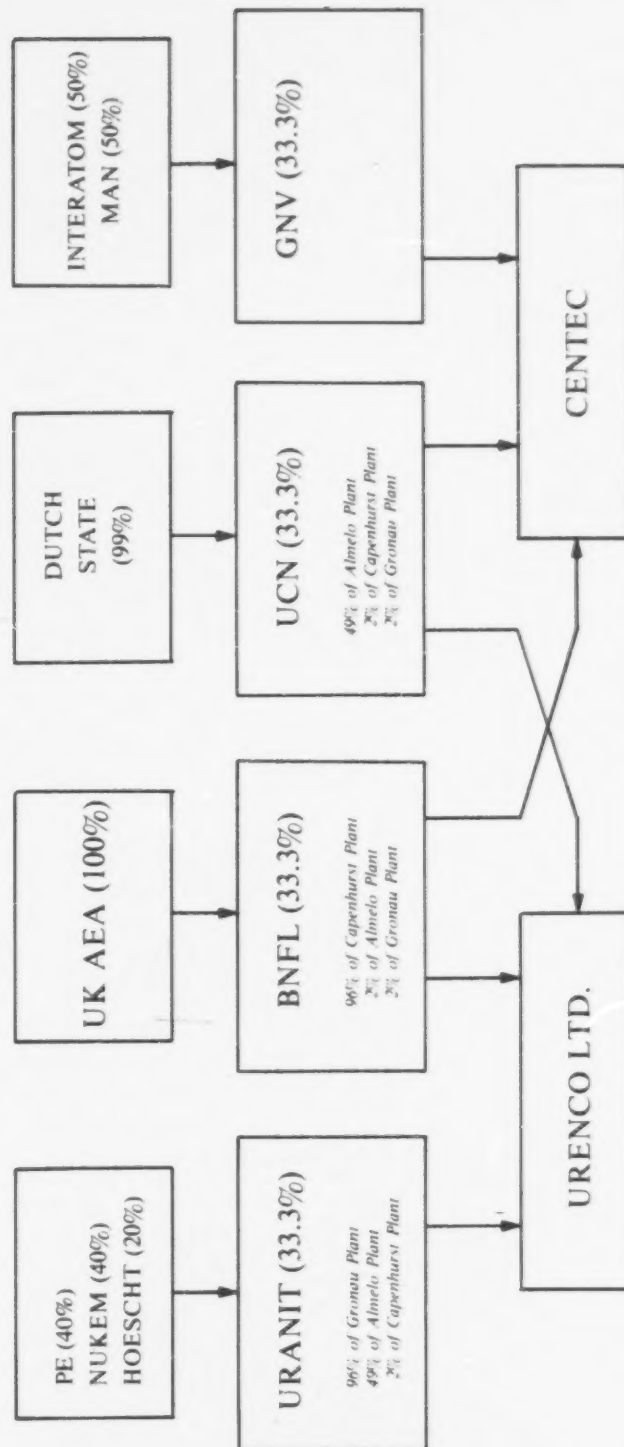
¹BNFL = British Nuclear Fuels Ltd.

²CEGB = Central Electricity Generating Board.

³SSEB = South of Scotland Electricity Board.

⁴UKAEA = United Kingdom Atomic Energy Authority.

Figure 16
OWNERSHIP STRUCTURE OF URENCO GROUP



BNFL — British Nuclear Fuels Ltd. PLC
CENTEC — Gesellschaft fuer Centrifugentechnik mbH
GNV — Gesellschaft fuer Nukleare Verfahrenstechnik mbH
MAN — Maschinenfabrik Augsburg-Nuerenberg AG
PE — PreussenElektra AG
UCN — Ultra-Centrifuge Nederland NV
UKAEA — United Kingdom Atomic Energy Authority
URANIT — Uran-Isotopentrennungsgesellschaft mbH

EUROPE

USSR AND OTHER EASTERN EUROPEAN COUNTRIES

One of the outcomes of the Chernobyl accident, which took place in April 1986 near the city of Kiev in the USSR, has been a dramatic increase in western awareness of nuclear power programs in the USSR and Eastern Europe (Report 219, November 1986, contains a detailed article examining the effects of the Chernobyl accident on nuclear power programs around the world). Several western companies have increased their commercial contact with the USSR and Eastern Europe since the accident, particularly in the area of safety-related nuclear technology. Because of its international ramifications, the accident forced the Soviet government to open its nuclear-related activities to closer scrutiny by the West; as a result, the causes of the Chernobyl accident, and the technical aspects of many other nuclear power projects in the USSR are now better understood in the West. Nevertheless, details of actual power plant construction schedules, plant operating records, and siting of nuclear fuel facilities are still closely guarded by the USSR and other Eastern European countries.

The accident at Chernobyl Unit 4 (950-MWe LGR) occurred shortly after midnight on April 26, 1986, following a series of operating violations committed while conducting a turbogenerator experiment. According to Soviet accounts, the operators wished to test the capability of a turbogenerator to supply power to the main coolant pumps after it had been disconnected from the steam supply system. The operators disconnected the steam regulation valves from a turbogenerator while the reactor was operating at low power. Under normal circumstances, such a disconnection should have caused the reactor to shut down automatically, but the operators had disabled the automatic shut-down mechanism in order to be able to repeat the experiment if necessary. Following the disconnection of the turbogenerator, power to the main circulation pumps decreased, reducing the flow of water to the core. The flow reduction caused water to boil at a faster rate in the fuel channels, increasing steam generation. The increase in steam led to an increase in the core's reactivity (a result of the positive void coefficient inherent in the design), further increasing steam generation and causing a positive-feedback power excursion. The operators of the reactor noticed the rise in reactor power immediately after initiation of the experiment and ordered full emergency shutdown. All control and shutdown rods were inserted into the core. However, the control rods could not be inserted completely at once because they had been withdrawn from the core prior to the experiment, and in their elevated position were not capable of immediate shutdown. In the few seconds between when

shutdown measures were begun and when the accident occurred, power in the reactor is estimated to have increased to 100 times nominal full power, raising the temperature of the fuel to an estimated 3,000 degrees Celsius. The result was a disintegration of the fuel; its mixture with water led to a steam explosion that blew open the reactor building.

The USSR points out that the principal responsibility for the Chernobyl accident lies with the operators who conducted the turbogenerator experiment. Recently the government announced that the responsible persons, those who did not die in the accident, will be tried by a court of justice in Kiev this Spring. The Soviets also claim that a number of precautions against the recurrence of such an accident have been carried out. These include stricter operating guidelines in the employment of automatic safety systems, lower maximum control rod withdrawal limits, and techniques for reducing the positive void coefficient in LGRs that led to the power excursion at Chernobyl Unit 4.

Nuexco estimates that approximately 46 reactors are in commercial operation in the USSR, representing 29.2 GWe of installed capacity. Another 27 units (28.5 GWe) are under construction. Most of the plant sites contain multiple units and are located near the major cities in the European part of the USSR, where population density is greatest. At least 23 of the operating units are light-water cooled, graphite moderated reactors (LGRs) similar to the Chernobyl Unit 4 design, while the balance are mainly PWRs. Most of the units currently under construction are PWRs in the 1,000-MWe capacity range. The USSR's nuclear power plant construction firm, Atomenergoexport, has built or is building a number of PWRs in Eastern Europe, mostly of 400-MWe size. Seven units are operating in Czechoslovakia, six in the German Democratic Republic, four in Bulgaria, and three in Hungary. In addition, five units are under construction in Czechoslovakia, four in Poland, three in the GDR, two in Bulgaria, one in Hungary, and one in Rumania. Rumania has followed a somewhat independent line in its economic activities, including contracting with Atomic Energy of Canada Ltd. (AECL) for construction of several CANDU units.

In most of the East bloc countries, plans for continued development of nuclear power have not been substantially altered since the Chernobyl accident. On the contrary, the Soviet government's reaction to the accident was to downplay its significance and reiterate the state policy of nuclear power expansion. Although the USSR possesses substantial coal and oil resources, the government has emphasized the development of nuclear energy to decrease fuel transportation costs,

to alleviate the serious environmental problems created by heavy use of fossil-fuel fired power plants, to liberate coal and oil for sale on the international market, and to assert the USSR's competitive presence in an area of high technology. Bulgaria, Czechoslovakia, Hungary and the GDR have closely followed Soviet policy in this respect, while Poland has been less ambitious in its development plans, largely because of its extensive coal resources.

The USSR is known to have substantial uranium resources and several active uranium mining projects (Reports 200, April 1985, and 202, June 1985). Czechoslovakia is also known to have an important domestic uranium industry. However, details about ore reserves and uranium production are not well known outside the Soviet bloc. All other fuel cycle activities are well-developed in the USSR, including UF₆ conversion, enrichment by gaseous diffusion, fuel fabrication, spent fuel reprocessing, and plutonium production. However, production capacity in each of these stages of the fuel cycle, as well as location(s) of plants are kept secret. The USSR currently operates two Fast Breeder Reactors. The state nuclear fuel trading company Technobexport (TSE) is a long-term supplier of enrichment services to several European utilities, and during 1986 began selling enrichment in the western spot market.

The existence of a positive void coefficient in the Chernobyl Unit 4 reactor was the design flaw largely responsible for the accident condition that caused the explosion in that reactor. The following comments on the Chernobyl accident are a description in layman's terms of the effect of having a positive void coefficient in the design of a reactor; they are based on the contribution of the Lord Marshall, Chairman of the Central Electricity Generating Board, to a debate on nuclear power held on November 30, 1986 in the British House of Lords.

The Chernobyl reactor is a bit like having a powerful automatic car which has a design fault so that, if it is driven below 20 mph, the driver needs to give constant attention to the brake to stop the speed surging away — and if the fan-belt snaps or if a piece of rust interrupts the flow of coolant water, the car instantly accelerates to 100 mph or more with no chance for the driver to put the brake on in time. The Chernobyl reactor actually "accelerated" from a fraction of full power to 100 times full power in just four seconds.

The Russians have admitted that they knew of this design deficiency from the beginning and they chose to compensate for it, not by built-in engineering devices, but simply by instructing the operators to avoid potentially unsafe regimes. The Russians now admit that their designers made "a tremendous psychological mistake" in placing responsibility for the fundamental safety of the reactor upon the continuous discipline, attention, understanding and concentration of the reactor operators.

FAR EAST

JAPAN

Nuclear Plant Status

Following 1985's record addition of 4,830 gross MWe, no new nuclear plants entered commercial operation in Japan in 1986. In 1987, Japan is expected to add another 3,360 MWe. This intermittent entry of units into operation continues the pattern that began in 1980 (Table 26).

At the end of 1986, Japan had 34 operating units at 15 commercial nuclear power plant sites, with a total gross capacity of 24,686 MWe (Table 27). This includes 15 PWRs, 16 BWRs, one light-water-cooled heavy water reactor (Fugen), the Advanced Test Reactor (ATR) of the Power Reactor and Nuclear Fuel Development Corporation (PNC), one Fast Breeder Reactor (Joyo), and one Gas-Cooled Reactor (Tokai).

Operating procedures have improved and plant performance has increased in 1986; the average capacity factor of all the commercial plants was 76.2 percent in 1986, compared to 74.2 percent in 1985. The improvement is attributed to longer operational cycles and better regular maintenance. PWRs averaged 81 percent capacity factor, BWRs 72 percent, and the GCR 63 percent. By the end of the year, Japan also had 12 units under construction; 6 PWRs, 5 BWRs, and one FBR (Monju), with a total gross capacity of 11,068 MWe.

Table 28 identifies plants which have been approved for further planning. This table does not include utility projec-

tions still unapproved at the end of 1986, nor does it include Tohoku Electric Power Company's Onagawa 2, an 825-MWe BWR scheduled for operation in July 1995, for which a construction proposal will be submitted to the Electric Power Development Coordination Council (EPDCC) in March 1987. Currently, Japanese organizations are planning 14 additional units, with a total capacity of approximately 12,000 MWe net, including 2 PWRs, 11 BWRs, and one demonstration ATR (Ohma). Officially, however, only 2 PWRs and 5 BWRs, with a total capacity of 7,062 gross MWe have been approved by EPDCC for planning of construction and site licensing.

Other nuclear plants still in preliminary stages of planning and not yet submitted to the review of the EPDC include:

1. Onagawa Unit 3 (825-MWe BWR) for Tohoku Electric Power Company;
2. Higashidori Unit 1 (1,100-MWe BWR; expected operation in 1996) for Tohoku EPC;
3. Namie-Odaka (820-MWe BWR; expected operation after 1997) for Tohoku EPC;
4. Ohma (606-MWe demonstration ATR; expected operation after 1994) for the Electric Power Development Company (EPDC);
5. Ashihama Units 1 and 2 (1,110-MWe BWRs; expected operation in 1995 and 1996) for Chubu EPC;

Table 26
JAPANESE ANNUAL ADDITION
OF NUCLEAR GENERATING CAPACITY, 1966-1987

Year	Annual Addition (MWe, Gross)	Total MWe at Year-end
1966-75	—	5,278
1976	2,150	7,428
1977	566	7,994
1978	3,673 ¹	11,667
1979	3,450	15,117
1980	0	15,117
1981	559	15,676
1982	1,666	13,342
1983	0	13,342
1984	2,514	19,856
1985	4,830	24,686
1986	0	24,686
1987 ²	3,360	28,046

¹Including the Power Reactor and Nuclear Fuel Development Corporation's Advanced Test Reactor (Fugen).

²Expected 1987 operation.

Table 27

NUCLEAR POWER PLANTS IN JAPAN

Utility	Unit	Capacity (MWe Gross)	Type	Percent Complete ¹	COD ²
Chubu EPC ³	Hamaoka 1	540	BWR	100	Mar 1976
	Hamaoka 2	840	BWR	100	Nov 1978
	Hamaoka 3*	1100	BWR	95	Sep 1987
Chugoku EPC	Shimane 1	460	BWR	100	Mar 1974
	Shimane 2*	820	BWR	58	Feb 1989
Hokkaido EPC	Tomari 1*	579	PWR	61	Jun 1989
	Tomari 2*	579	PWR	26	Jun 1991
Japan Atomic Power Company (JAPC)	Tokai	166	GCR	100	Jul 1966
	Tokai 2	1100	BWR	100	Nov 1978
	Tsuruga 1	357	BWR	100	Mar 1970
	Tsuruga 2*	1160	PWR	98	Mar 1987
Kansai EPC	Mihama 1	340	PWR	100	Nov 1970
	Mihama 2	500	PWR	100	Jul 1972
	Mihama 3	826	PWR	100	Dec 1976
	Takahama 1	826	PWR	100	Nov 1974
	Takahama 2	826	PWR	100	Nov 1975
	Takahama 3	870	PWR	100	Jan 1985
	Takahama 4	870	PWR	100	Jun 1985
	Ohi 1	1175	PWR	100	Mar 1979
Kyushu EPC	Ohi 2	1175	PWR	100	Dec 1979
	Genkai 1	559	PWR	100	Oct 1975
	Genkai 2	559	PWR	100	Mar 1981
	Genkai 3*	1180	PWR	4	Jul 1993
	Genkai 4*	1180	PWR	0.5	Jul 1995
	Sendai 1	890	PWR	100	Jul 1984
PNC ⁴	Sendai 2	890	PWR	100	Nov 1985
	Fugen	165	ATR	100	Mar 1979
Shikoku EPC	Monju*	280	FBR	23	Nov 1992
	Ikata 1	566	PWR	100	Sep 1977
	Ikata 2	566	PWR	100	Mar 1982
Tohoku EPC	Ikata 3*	890	PWR	5	Mar 1992
	Onagawa 1	524	BWR	100	Jun 1984
Tokyo EPC	Fukushima I-1	460	BWR	100	Mar 1971
	Fukushima I-2	784	BWR	100	Jul 1974
	Fukushima I-3	784	BWR	100	Mar 1976
	Fukushima I-4	784	BWR	100	Oct 1978
	Fukushima I-5	784	BWR	100	Apr 1978
	Fukushima I-6	1100	BWR	100	Oct 1979
	Fukushima II-1	1100	BWR	100	Apr 1982
	Fukushima II-2	1100	BWR	100	Feb 1984
	Fukushima II-3	1100	BWR	100	Jun 1985
	Fukushima II-4*	1100	BWR	95	Sep 1987
	Kashiwazaki 1	1100	BWR	100	Sep 1985
	Kashiwazaki 2*	1100	BWR	27	Oct 1990
	Kashiwazaki 5*	1100	BWR	62	Apr 1990
Total In Operation		24,686			
Total Under Construction		11,068			
TOTAL		35,754			

* Unit under construction.

¹ According to published sources.

² Actual or expected Commercial Operation Date.

³ EPC = Electric Power Company.

⁴ Power Reactor and Nuclear Fuel Development Corporation.

FAR EAST

Table 28
**APPROVED¹ PLANNED NUCLEAR POWER PLANTS
IN JAPAN IN 1986**

Unit	Utility	Capacity (MW ² Gross)	Type	COD ²
Ohi 3	Kansai EPC ³	1180	PWR	Aug 1991
Ohi 4	Kansai EPC	1180	PWR	Jun 1992
Noto 1	Hokuriku EPC	540	BWR	Mar 1993
Kashiwazaki 3	Tokyo EPC	1100	BWR	Jul 1993
Kashiwazaki 4	Tokyo EPC	1100	BWR	Jul 1994
Hamaoka 4	Chubu EPC	1137	BWR	Jul 1994
Maki 1	Tohoku EPC	825	BWR	Sep 1996
Total gross capacity in planning:		7,062		

¹Approved for planning but without authorization to start construction at this time. Following completion of public hearings, plans are submitted for the approval of the Electric Power Development Coordination Council (EPDCC). Utility plans not approved by EPDCC are usually not available for publication.

²Expected Commercial Operation Date.

³Electric Power Company.

6. Kashiwazaki-Kariwa Units 6 and 7 (1,356-MWe Advanced BWRs) for Tokyo EPC;

7. Koura Unit 1 (870-MWe PWR) for Kansai EPC.

The Japan Atomic Energy Research Institute (JAERI) also has plans to build a 30-50 MWt research reactor based on an experimental HTGR design. However, following a report recommending cuts in the program, these plans may be scaled down and delayed in the future.

In addition, there are several nuclear plants that do not contribute to commercial generation, and which are not included in the tables.

1. Joyo, an FBR, was first put in operation by the Power Reactor and Nuclear Fuel Development Company (PNC) in 1979.

2. The Japan Power Demonstration Reactor (Tokai-JPDR), a 12.5-MWe test BWR (90-MWt) was first put in operation in 1963 by JAERI and since September 1986, has been in the process of decommissioning.

3. The nuclear ship Mitsu, an independent project under the Science and Technology Agency (an agency of MITI), has been completed but is not in operation at the moment.

4. The Japan Material Test Reactor (JMT), a 10-MWt test reactor operated by JAERI, was initially designed to test uranium-aluminum plates enriched to 93-percent U₂₃₅, but now is being tested with fuel elements enriched to 45-percent.

Installed Capacity Forecasts

In 1986, nuclear reactors generated more than a quarter of Japan's total electric power. Official projections by the Jap-

anese government estimate that this share will reach 35 percent by 1995 and 58 percent by 2030. Japan's goal is to reduce its dependence on power generated by oil-fired plants. These projections are optimistic; growth of future nuclear power generation may be limited by economic factors and site licensing regulations.

Following a first forecast by the utilities in the middle of 1986, the Long Term Planning Committee of the Atomic Energy Commission published new and lower projections. Compared to a current capacity of 24.7 GWe, the Committee projected installed nuclear capacity in 2000 to be 52 to 62 GWe (gross) and in 2030 to be 107 to 150 GWe (gross). These figures could be further revised downward. Other forecasts project Japan's installed nuclear capacity to be 50 GWe by the year 2000.

Japan's Economy in 1986

1986 was the year of the rising yen. Although a strong Japanese yen is expected to reduce the competitiveness of Japanese exports in the long run, low oil prices and a weak US dollar have contributed to a significant fall (9 to 16 percent) in fuel import costs, boosting Japanese exports in the near term.

In the first half of fiscal year 1986 (i.e., April through September), the pre-tax profits of Japan's nine utilities rose 62.5 percent, even though electricity sales (kilowatt hours) fell 0.5 percent due to lower power consumption in manufacturing industries. In January 1987, for example, the president of an electric power company noted a 7.5 percent reduction in

power consumption for his utility during 1986. Japan's economy is gradually shifting from heavy industry toward services and high technology. As a consequence, power requirements are slowly shifting from a base-load to a peak-load mode, giving the electric power utilities increasing influence on the future economy of Japan.

The volatility of prices in the market for fuels has prevented the Ministry of International Trade and Industry (MITI) from establishing a stable long-term energy forecast for Japan and several revisions were published in 1986 by several organizations. It is obvious, however, that nuclear power generation, competing with oil, coal, and liquid natural gas (LNG), has become a leading source of power for Japan. It is expected to retain that position despite a relatively larger current installed capacity for oil-fired plants. Although signs indicate a slower growth in industrial power consumption, planning and construction times still reflect a vigorous program. Construction times for nuclear plants in Japan have risen from an average of 4.9 years in the 1970s to 5.3 years in the 1980s. In comparison, average construction times in the USA rose from 6.7 to 11.2 years.

Uranium Inventories

Nuexco data indicate that, contrary to recent trends in other parts of the world, uranium inventories in Japan continued to increase in 1986. They are expected to grow moderately in 1987. Inventories on hand, including fuel in processing, are about 6 to 8 times higher than the current annual consumption. The main sources of U_3O_8 in the coming years will continue to be Canada, Niger, Namibia, and Australia. Japanese utilities are expected to begin contract negotiations in 1988 for additional uranium procurement, particularly with suppliers in Canada and Australia. Currently, one utility has a contract with a US producer.

During their 1986 annual price negotiations for deliveries under long-term uranium supply contracts with South Africa's Nuclear Fuels Corporation (NUFCOR), several Japanese utilities agreed to pay slightly above US\$30.00 per pound U_3O_8 for FY87 deliveries (ending March 31, 1987). This price represents a reduction of about \$2.00 per pound from the price paid for FY86 deliveries, and is about \$5.00 lower than the agreed price for FY 1983. It is expected that future price negotiations in 1987 will further reduce existing contract prices for uranium delivered by NUFCOR and RTZ.

Strict application of sanctions against South African imports to the US could affect the procurement schedules for natural and enriched uranium by some Japanese utilities in the future. Although Japanese utilities have conversion arrangements with virtually all western conversion facilities, the potential inability to convert southern African-origin

U_3O_8 in the USA could disrupt fuel procurement planning for some utilities in Japan. At present, some Japanese utilities utilize DOE for all of their enrichment requirements, while others have turned to Cogema and Eurodif for a fraction of their requirements. Overall, well over three-fourths of the enrichment requirements of Japanese utilities are contracted to DOE.

Fuel Cycle Facilities

Japan's fuel cycle companies and utilities are proceeding with their plans to build uranium enrichment, low-level waste storage, and reprocessing facilities at a common site near Rokkasho-Mura, in Aomori Prefecture, located at the northern end of Japan's main island of Honshu (Figure 17). The site will cover some 6.5 square kilometers (2.6 square miles), including greenbelt areas around the facilities. Investment in the three facilities is likely to exceed US \$4 billion, promising industrial growth for a relatively less developed region of Japan. Moreover, the facilities represent another step in Japan's push toward self-sufficiency in the nuclear fuel cycle. Current status of the planned facilities is summarized in Table 29.

Enrichment

In 1985, the Japanese utilities and other nuclear industry participants organized Japan Nuclear Fuel Industries (JNFI) to own and operate a domestic enrichment plant with a capacity of 1.5 million SWU per year. The Federation of Electric Power Companies (FEPC), Japan's utility coordinating organization and JNFI revised the plan in 1986, dividing it into two phases. Phase 1 will begin in 1988 with the construction of a 600,000 SWU-per year plant. Although the exact schedule has not been determined, Phase 2 will add 900,000 SWU per year to the plant's capacity, for a total capacity of 1.5 million SWU per year. Centrifuge technology initially developed by the Power Reactor and Nuclear Fuel Development Corporation (PNC) has been chosen as the preferred enrichment technology for those plans.

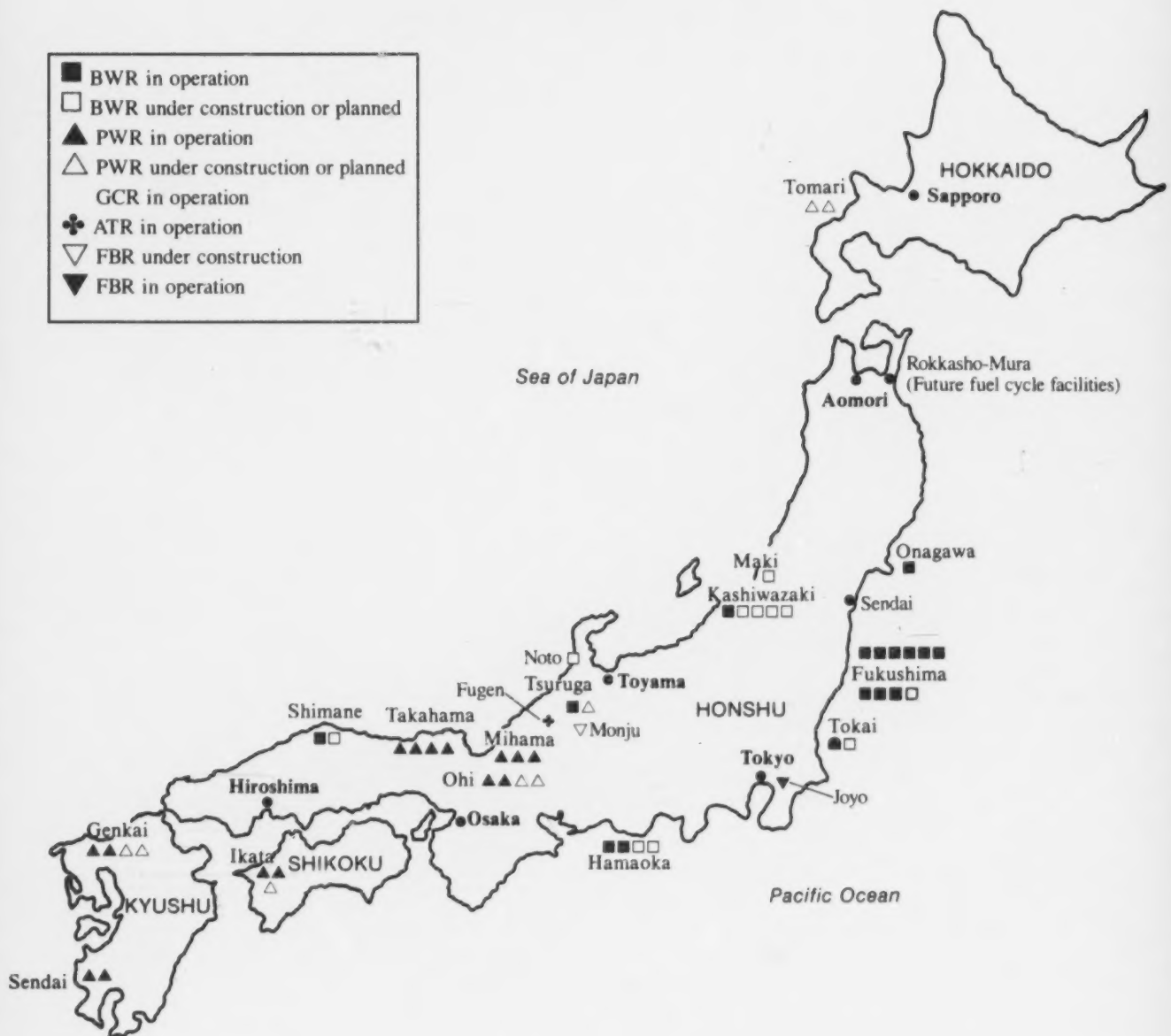
Following the successful operation of the first centrifuge demonstration plant, PNC began construction in November 1985 of a larger demonstration centrifuge enrichment facility on the western side of Honshu. This plant is scheduled to produce 100,000 SWU per year in 1987 and 200,000 SWU per year in 1988, and will act as a technology bridge between the first PNC pilot plant and the future JNFI commercial plants.

Although JNFI's initial plans called for a capacity of 3 million SWU per year at Rokkasho-Mura by 2004, several recent developments in the enrichment market have influenced their planning. When the US DOE announced the

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Figure 17
NUCLEAR POWER PLANTS IN JAPAN IN 1986



cancellation of its gas centrifuge enrichment program (GCEP) in favor of existing diffusion technology and future laser technology, the Japanese utilities reevaluated their domestic programs, taking into consideration the lower expected cost of enrichment using laser isotope separation methods. By the end of 1985, the utilities had decided to reduce the Rokkasho-Mura enrichment plant capacity to 1.5 million SWU per year using centrifuge technology, and to build a facility that would use laser technology, possibly at a different location. The utilities, JNFI, and the Central Research Institute of the Electric Power Industry plan to conduct the joint development program. The group plans to spend approximately US\$100 million over a five-year period, to build a demonstration laser enrichment facility with an annual capacity of 1,000 to 5,000 SWU. The start of the five-year period has not been scheduled, but the target date for commercialization of the project is the year 2000. In addition to laser and centrifuge technologies, Japan is also allocating some funds for research on other enrichment technologies.

Fuel Reprocessing

In 1980, the Japanese utilities organized Japan Nuclear Fuel Services (JNFS) to oversee the construction and opera-

tion of a commercial-scale reprocessing plant, also located at Rokkasho-Mura. Throughout 1986, planning and site preparation continued on the reprocessing facility, which will be capable of processing 800 tonnes per year of spent fuel by 1995, and an adjacent 3,000-tonne spent fuel storage facility, scheduled for operation in 1991 to allow for 4 years of fuel cooling. Most of Japan's spent fuel is currently stored by the utilities in pools at the nuclear plant sites, although some is being reprocessed through service contracts with European suppliers.

Based on a European reprocessing technology, the plant design will be adapted from PNC's 210-tonne per year demonstration plant at Tokai-Mura. PNC has operated the demonstration plant since 1977, with some interruptions caused by technical problems. In 1986, PNC reprocessed 46 tonnes of spent fuel at the demonstration plant, bringing the cumulative total to 298 tonnes by the end of 1986.

To prepare for oceanographic environmental surveys for the entire complex, JNFS and JNFI needed to obtain agreements from five local fishing associations. Although four agreements were secured during 1985, the fifth was not received until March 1986. JNFS and JNFI recently completed negotiations for the purchase of almost 750 hectares (1,875 acres) at a cost of approximately 72.5 billion yen

Table 29

SPECIFICATIONS OF JAPAN'S COMMERCIAL FUEL CYCLE FACILITIES

	Uranium Enrichment Plant	Spent-Fuel Reprocessing Plant	Low-Level Waste Storage Plant
Location (Prefecture)	Oishitai Rokkasho-Mura Aomori	Iyasaki Rokkasho-Mura Aomori	Oishitai Rokkasho-Mura Aomori
Operating Company	JNFI	JNFS	JNFI
Scale	Phase 1 - 600,000 SWU/year Phase 2 - 900,000 SWU/year 1.5 million SWU/year	800 tons/year plus 3,000 tons of spent-fuel storage	200,000 m ³ (About one million 55-gal. drums) ¹
Area	About 3.0 square kilometers (including low-level waste storage area)	About 3.5 square kilometers	About 3.0 square kilometers (including enrichment facility)
Schedules			
Construction	Start in 1986	Start in 1986	Start in 1986
Operation	1991	1997	1991

¹May be expanded to 600,000 cubic meters (about three million drums).

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(approximately US \$470 million). The reprocessing technology will most likely be French. Following a brief interruption in negotiations in 1986, it was announced in January 1987, that an agreement on reprocessing technology and services had been reached between Japan and France's Societe Generale pour les Techniques Nouvelles (SGN, 66% owned by Cogema) at a cost of about 48 billion yen. JNFS is also examining a nitric acid recovery process from British Nuclear Fuels PLC and other technology from KEWA, an engineering subsidiary of the West German fuel cycle consortium DWK, for removal of iodine-129. The Power Reactor and Nuclear Fuel Development Corporation (PNC) is also involved in plutonium and uranium conversion processes.

Low Level Waste Storage

Part of the FEPC recommendation outlined a plan for the transport and storage of low-level waste generated by the nation's light-water reactors and other nuclear facilities to a national facility, also located at Rokkasho-Mura. At present, each nuclear power plant has its own on-site storage for low-level wastes, such as contaminated equipment and clothing. By 1991, the national facility will have the capacity to store approximately one million 55-gallon (230 liter) drums. The original plan envisioned a possible expansion of the facility to allow for the storage of the equivalent of three million drums. The facility is expected to cost about \$400 million.

THE PEOPLE'S REPUBLIC OF CHINA

Introduction

With a land area of almost 10 million km² and a population over one billion, China's development of a strong nuclear power industry will require building a nuclear infrastructure on a very large scale. China currently relies on fossil power plants for approximately 70 percent of its electrical power, and hydroelectric power plants for about 30 percent, and coal is certain to provide a major share of future power generation. The most recent five-year plan (1986-1990) called for a 25-GWe increase in coal-fired power plants. However, transport distances cause a significant problem: few coal reserves are located in the central coastal provinces where much of the population and about 30 percent of the industry are located. Nuclear power, with its consumption of a low-volume fuel, appears to be an optimum solution to the electric power needs in China.

By 1964, China had a diffusion enrichment plant, about 17 plutonium production reactors of Russian design (for the military nuclear program), and a multitude of research projects including reprocessing and nuclear submarine technology. A civilian nuclear program was announced in 1978 but serious planning did not begin until 1984, when Li Peng was named Chairman of the newly-formed Nuclear Power Leadership Group. At that time, China was already operating two small research reactors in Beijing: a 3.5-MWe pool-type unit and a 7-MWe HWR that was later upgraded to larger capacity. The Atomic Energy Research Institute in Shanghai had conducted research on reactor design, developing prototype reactors for electricity and industrial steam generation. In 1984, a 27-MWe PWR began operating.

Considerable manpower and technical expertise, largely trained in the military nuclear programs, are available to develop a civilian power program. With its organization and leadership still evolving, the Chinese nuclear program has significant potential, but also faces significant obstacles.

1986 Planning Decisions

The original ambitious plan announced in 1985 called for the installation of 10,000 MWe of nuclear generated capacity by the year 2000. This was revised downward in 1986 to a target of 10 nuclear power plants, having a total capacity of 6,000 MWe, in operation by the year 2000. In part, this reduction in planned capacity resulted from an unexpectedly large volume of imports, which had drained China's foreign currency reserves. Also, in early 1986, in the context of discussions concerning the seventh five-year plan, the Ministry of Nuclear Industry (MNI) finally won control of the

civilian nuclear program from the Ministry of Water Resources and Electricity Power (MWREP), resulting in a more coordinated overview of the program.

In early 1986, the decision was made to postpone plans for two Kraftwerk Union (KWU) 1,000-MWe PWRs at Sunan, near Shanghai (Figure 18). That decision in turn led to the postponement of some countertrade proposals, such as the export of 6,000 MTU of uranium from the PRC to utilities in the Federal Republic of Germany, and shipment by year 2000 of some 150 MTU of spent fuel from the FRG to China. The cancellations represented a serious setback to KWU, the West German reactor supplier which had virtually been awarded the contract. In an effort to balance the loss of prospects for near-term countertrade with the FRG, and more important, to generate foreign currency reserves, a new campaign was launched to boost China's nuclear industry exports by selling uranium concentrates on the world market, and offering Chinese technical expertise.

Civilian Nuclear Power Plants

The first sizable nuclear plant expected to enter commercial operation will be a 300-MWe PWR located at Qinshan, near Shanghai. The Qinshan unit started as an indigenous design based on nuclear submarine technology. Later, however, China decided to order some components abroad. When completed, the reactor will include a pressure vessel from Mitsubishi Heavy Industries (Japan), steam generator tubes from Sandvik (Sweden), main coolant pumps from KSB (West Germany), steam isolation valves and turbine by-pass valves from Sulzer (Switzerland) and cables from Pirelli (Italy). Current plans call for completion and operation in 1989-1990.

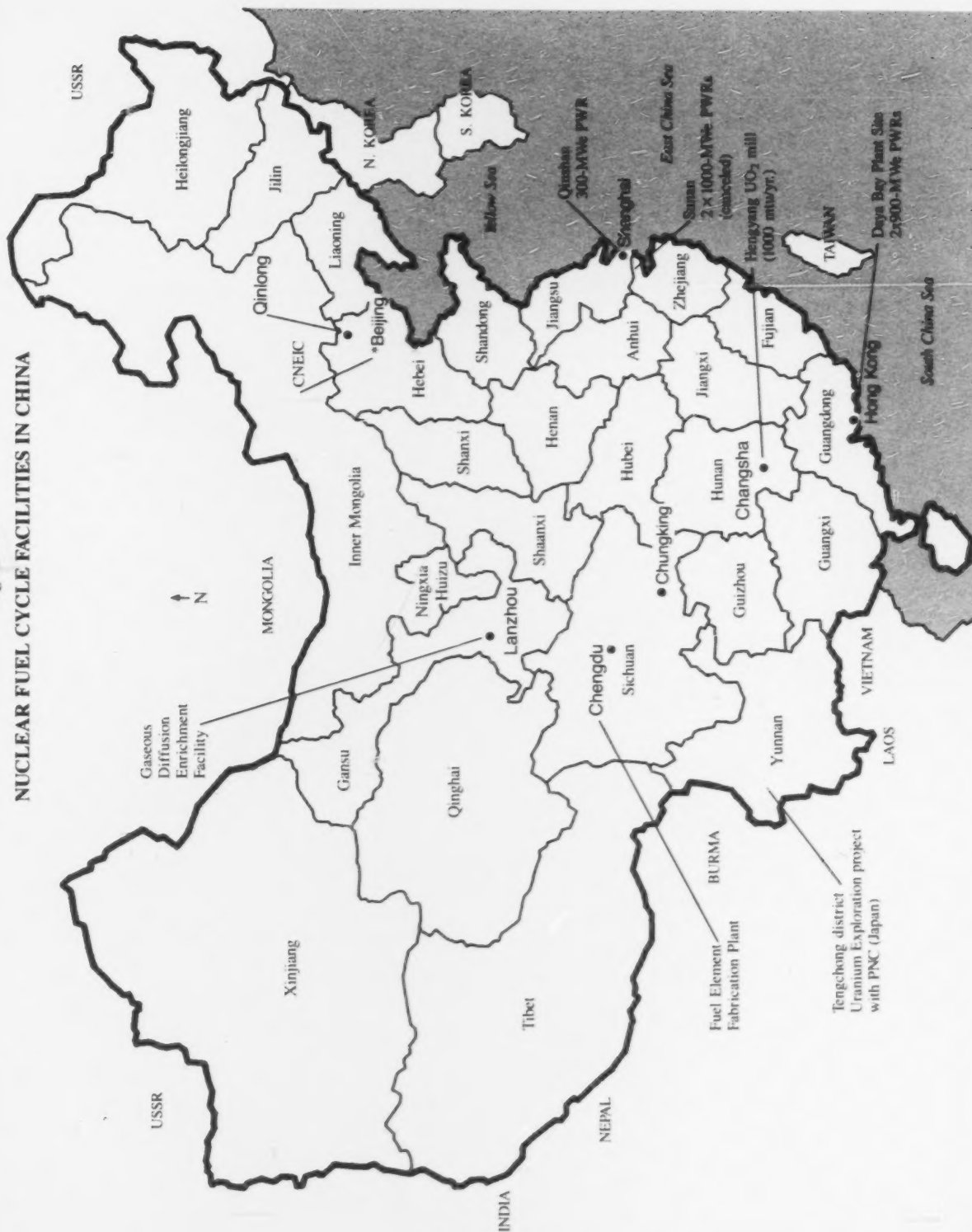
A larger project is under construction at Daya Bay, 80 km from Hong Kong, where 70 percent of the electricity produced will be sold. The plant site will contain two 980-MWe PWRs. Letters of intent were signed in March 1986 with Framatome to build the units, and in April with General Electric Corporation (UK) to provide the turbines. Electricite de France (EdF) will provide architect-engineering and consulting services. In September 1986, Framatome announced the signing of the Daya Bay agreement. The owner of the plants will be the Guangdong Nuclear Power Joint Venture Company (GNPJVC), with a 25-percent participation by the Hong Kong utility, China Light and Power. The current, and probably optimistic plans call for operation of the first plant by 1993 and the second plant by 1994.

A 5-MW reactor intended for heating water is also being built about 60 km northwest of Beijing. The small reactor

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Figure 18
NUCLEAR FUEL CYCLE FACILITIES IN CHINA



combines technology from the USSR and the FRG, and is scheduled for completion by September 1987. In addition, China's nuclear planning includes building a number of 600-MWe units, which would be based on the Qinshan plant design. It is unknown whether contributions from foreign companies will be significant but KWU, Westinghouse, and the USSR have already offered their services.

Uranium Resources

In the 1950s, China started uranium exploration programs with the assistance of geologists from the USSR. Mining and milling started in 1962 for military purposes and uranium has been stockpiled since, in the form of UO_2 . Based on estimates by Chinese geologists, and official statements that China could easily run fifteen 1000-MWe nuclear plants for 30 years using its domestic uranium resources, it is estimated that economically exploitable reserves in China amount to a minimum of 260 million pounds U_3O_8 (100,000 MTU). Total known reserves are estimated at over 2 billion pounds U_3O_8 (800,000 MTU); including speculative reserves, this figure could be as high as 8 billion pounds U_3O_8 (3 million MTU).

Although information about Chinese uranium deposits is not widely available, occurrences of uranium have been reported in many provinces, chiefly in the northern and southeastern parts of the country. In the southeast, important discoveries have been reported in Yunnan, Guangxi, Guangdong, and Hunan provinces. The mill most visited by western observers is the Hengyang facility, south of Changsha in Hunan province. The mill reportedly receives ore by rail from at least four separate mines, whose uranium-bearing ore is of several different types, including sandstone, slate, shale, and volcanic rocks. China has assigned the mill, which has a reported annual capacity of over 1,000 MTU, to produce uranium concentrates for export. Other mills will be made available as necessary to fulfill export commitments. Several large discoveries have also been made near the border of Yunnan and Guangdong provinces. Chinese statements indicate that the deposits occur mainly in Tertiary sedimentary rocks. Additional deposits are known to occur in north-east China; in northern Shanxi province west of Beijing, in Xinjiang province near long-established uranium production facilities in the USSR, and in Liaoning province, near the North Korean border. Most uranium in China is mined by underground methods, with a small percentage mined in open pits. The Chinese government considers these natural uranium resources to be very important in its effort to solicit foreign participation and financial assistance for their upcoming industrial expansion.

An additional preliminary exploration program began in 1984 in a joint venture between the Bureau of Uranium Geology (under the Ministry of Nuclear Industry) and the

Power Reactor and Nuclear Fuel Development Corporation (PNC) of Japan. The program investigated about 4,600 km² near Tengchong in southwest Yunnan province, near the Burmese border. Some findings already suggest deposits containing grades of 0.2 to 0.3 percent uranium.

Another joint venture has been undertaken between China and the Uranium Resources Development Committee (URDC) of Japan, an organization which involves all the Japanese utilities, as well as trading companies and other entities. The participants are currently considering a feasibility study, scheduled to take three years, to evaluate development of a uranium mine. The Qinlong mine is located 250 km northeast of Beijing in Hebei province. With estimated reserves of 12 million pounds U_3O_8 already planned for export, a preliminary target may be to start production from Qinlong in 1990 at a rate of 300,000 to 400,000 pounds U_3O_8 per year, if all conditions are favorable. Another joint venture for uranium exploration with a German company is underway in Shanxi province.

Uranium Marketing

In addition to being the sole export agent for all the research institutes, factories, and mines affiliated with the Ministry of Nuclear Industry, the China Nuclear Energy Industry Corporation (CNEIC) is in charge of marketing China's uranium outside of China. The first uranium exports were made to PNC of Japan, starting in 1981 in small amounts of 30 to 40 MTU for each delivery.

In December 1985, a uranium sales agreement was signed with the West German utility Gemeinschaftskernkraftwerk Neckar (GKN). The first delivery was made in the fourth quarter of 1986. The U_3O_8 was delivered by rail to the USSR for conversion and enrichment. The contract calls for future annual deliveries of approximately 100 MTU, subject to GKN's option to reduce the quantity. In April 1986, Electricite de France (EdF) signed a contract with the PRC for uranium deliveries through 1990. A first delivery was made in October 1986 at the conversion facilities of Comurhex, following a shipment by sea from Shanghai.

Starting in 1988, the average combined deliveries to GKN and EdF could reach over 300 MTU per year if maximum quantity options are chosen. China is eager to negotiate additional uranium sales, and to this end CNEIC representatives have been traveling actively in the USA and Europe, meeting utility buyers and describing China's uranium production plans and capabilities. At the present time, CNEIC could export more than 400 MTU annually in addition to the current commitments to EdF and GKN. CNEIC is confident that China could soon export up to 1,000 MTU per year for the next decade.

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THE PHILIPPINES

The only nuclear power plant in the Philippines, Bagac-San Juan Unit 1 (also known as Philippines National Power Plant 1, PNPP-1), had been officially scheduled to begin commercial operation in the first quarter of 1985. However, the issuance of an operating license is still pending. The National Power Corporation (NPC) has filed suit in Manila against Westinghouse over contractual payments resulting from the delay in the issuance of the operating license. In spite of lower oil prices, the delay puts a serious financial burden on the utility, which had anticipated the startup of the 620-MWe, two-loop PWR in 1985.

In recent years, considerable public opposition surrounded the plant's operation, intensifying in the last months of the Marcos regime. Immediately prior to her election, President Corazon Aquino had stated that the plant, which she considered unsafe, would be scrapped if she was elected. In the first year of her administration, however, no further official announcements have been made regarding the future of the plant, other than that the plant would not operate in spite of acute power shortages. In addition, the Philippine Supreme Court has stalled any hope to start the plant, pending further licensing hearings. It is unclear at this time whether the plant will be mothballed, or will be dismantled for resale of individual components. Following the decision not to operate the plant, all the plant's assets, including the fabricated fuel on site, have been transferred from the utility to the government. The Aquino government also has asked for rescheduling of the US Export-Import Bank loans related to the plant, but rescheduling may be difficult if the plant is to be decommissioned.

Unsolicited offers have been received by the government and the utility (the National Power Corporation) for the purchase of the fabricated initial core assemblies and other fabricated fuel assemblies in inventory, representing some 68 MTU in enriched UO₂ fuel assemblies. However, the indecision about the future disposition of the plant has made it impossible for the government to issue public requests for bids.

SOUTH KOREA

In April and August 1986, Korea Nuclear Units (KNU) 6 and 7 entered commercial operation, bringing South Korea's installed nuclear gross generating capacity to over 4,700 MWe, accounting for 26.4 percent of its total generating capacity. Korea currently has six nuclear plants in operation and three under construction (Table 30, and Figure 19). In addition, the state utility, Korea Electric Power Corporation

(KEPCO), chose Combustion Engineering (C-E) of the USA as the preferred vendor to negotiate the design and construction of Korea's next two nuclear plants, KNU units 11 and 12. The addition of these two 950-MWe PWRs, the construction of which is expected to start in mid-1989, will enable South Korea to provide more than 43 percent of its total electric power by nuclear generation when these plants begin operation around 1996.

Table 30

NUCLEAR POWER UNITS IN SOUTH KOREA

Unit ²	Plant	MWe	Type	COD ¹	Percent Complete ³
KNU 1	(Ko-Ri)	556	PWR	1978	100
KNU 2	(Ko-Ri)	605	PWR	1983	100
KNU 3	(Wolsung)	629	Candu	1983	100
KNU 5	(Ko-Ri)	895	PWR	1985	100
KNU 6	(Ko-Ri)	895	PWR	1986	100
KNU 7	(Yeonggwang)	900	PWR	1986	100
KNU 8	(Yeonggwang)	900	PWR	1987	99
KNU 9	(Ul-Jin)	943	PWR	1988	84
KNU 10	(Ul-Jin)	943	PWR	1989	71
KNU 11	(Yeonggwang)	864	PWR	1995	planned
KNU 12	(Yeonggwang)	864	PWR	1996	planned

¹Actual or expected Commercial Operation Date.

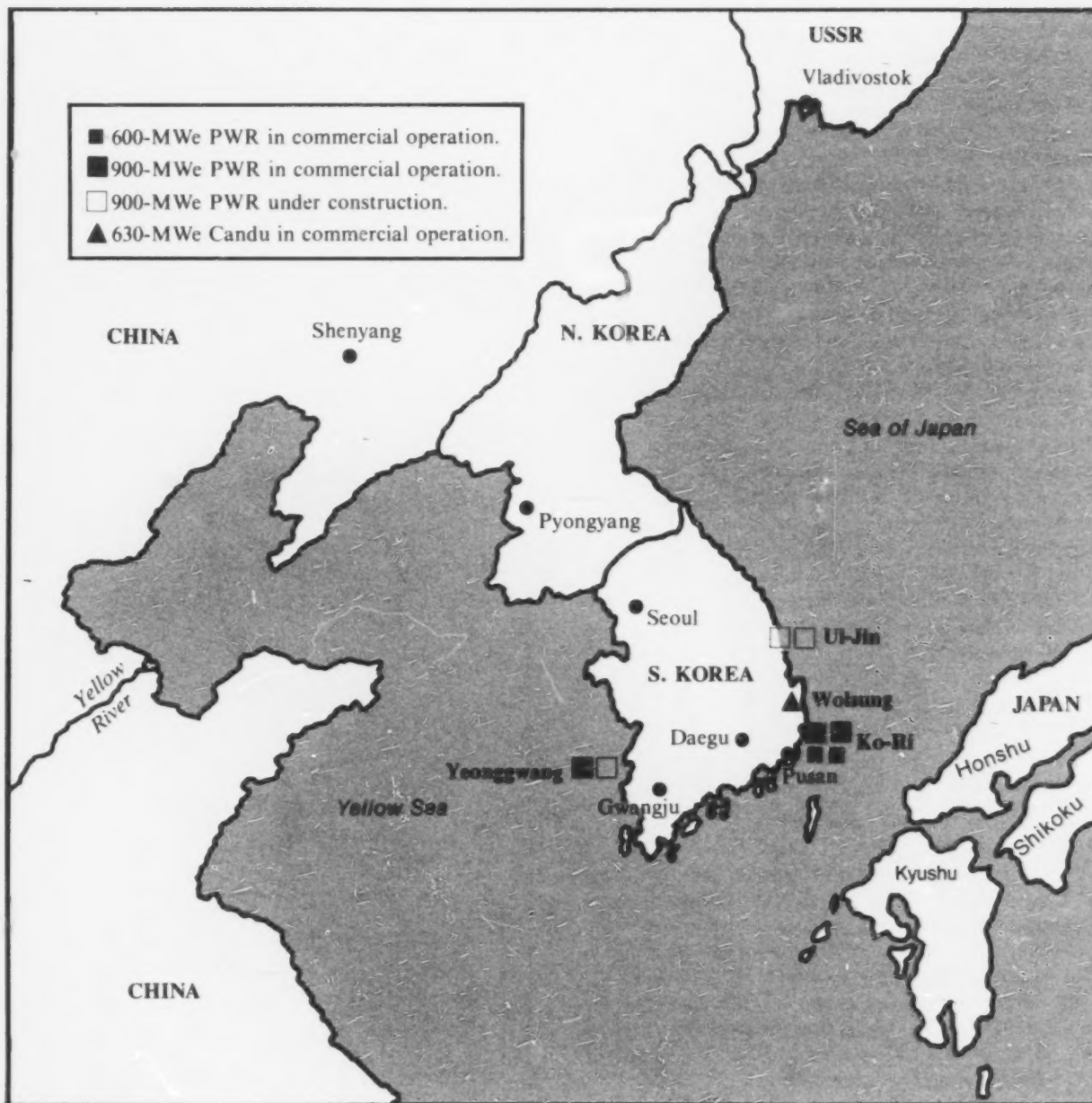
²There is no KNU 4

³According to public data.

The contract award for KNU 11 and 12 involves a number of suppliers, both Korean and foreign, and will be based upon a high degree of technology transfer. The units are expected to cost between \$3 and \$3.5 billion each. The turbine generators for the units are to be supplied by General Electric (GE), certain architect-engineering services by Sargent & Lundy, and the nuclear steam supply system by C-E. Project management will be under KEPCO, the first time the utility is attempting to operate in that role. Previous plants in South Korea were largely built as turnkey projects, by Westinghouse, Atomic Energy of Canada Ltd., and Framatome. The percentage of local manufacture of Korea's nuclear plants has steadily increased, from about 8 to 10 percent for KNU 1 to over 40 percent for units 9 and 10. For KNU 11 and 12, domestic participation is expected to be about 70 percent in terms of cost.

Korea's nuclear industry clearly will benefit from the strong desire to increase the degree of self-sufficiency and

Figure 19
NUCLEAR POWER UNITS IN SOUTH KOREA



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autonomy in nuclear development, from construction and manufacturing to fuel fabrication. KEPCO owns or controls several smaller companies that will assume major responsibility for nuclear power development. The Korea Power Engineering Company (KPOEC) is an engineering subsidiary of KEPCO, responsible for architect-engineering. KPOEC conducts joint ventures and other cooperative arrangements with overseas companies. Korea Heavy Industries and Construction (KHIC), managed and partially owned by KEPCO, is the designated manufacturer and umbrella licensee to the main supplier companies abroad. As such, KHIC can award subcontracts to smaller Korean companies.

Although final negotiations may extend well into 1987, Korean industry will be given major contracts under the project. The Korea Advanced Energy Research Institute (KAERI) will hold the license for the nuclear steam supply system, and KPOEC will manage balance-of-plant engineering. Component manufacturing will be divided between C-E, General Electric, and KHIC, which will be the prime contractor for the plant.

Korea has also announced its intent to build its own fuel fabrication facility, scheduled to begin operation in early 1989 at Daeduk, south of Seoul. This plant will have a production capacity of about 200 tonnes per year, and is estimated to cost over \$65 million. Kraftwerk Union (KWU) is providing the basic design, in collaboration with Reaktor-Brennelement Union (RBU). The plant will be operated by Korea Nuclear Fuels Company, a subsidiary of KEPCO.

KEPCO has also been looking at possible investments in uranium production facilities in other countries. Within the next three to four years, some of Korea's current long-term uranium contracts will expire, and the utility may attempt to secure up to 30 percent of its future requirements through direct investment in production and exploration projects.

TAIWAN

During 1986, Taiwan's nuclear power program was beset by uncertainty and indecision. In 1985, an order from the Ministry of Economic Affairs temporarily suspended plans for Units 7 and 8. After the accident at Chernobyl in April 1986, renewed planning and construction seemed even more uncertain. Taiwan currently operates 6 reactors at three plant sites, with a total installed capacity of 5,144 MWe (Table 31). Units 7 and 8 had originally been expected to start operation in the early 1990s, at Yenliao, on the coast east of Taipei (Figure 20). At best, if an order is approved in 1987, units 7 and 8 would not operate before 1996 and 1997 respectively.

Table 31

NUCLEAR POWER UNITS IN TAIWAN

Unit	MWe	Type	COD
Chinshan 1	604	BWR	Dec 1978
Chinshan 2	604	BWR	Jul 1979
Kuosheng 1	948	BWR	Dec 1981
Kuosheng 2	948	BWR	Mar 1983
Maanshan 1	890	PWR	Jul 1984
Maanshan 2	890	PWR	May 1985

Figure 20

NUCLEAR POWER UNITS IN TAIWAN



Historically, the performance of nuclear plants in Taiwan has been well above the world average. The share of electricity generated by nuclear power in 1986 remains over 53 percent; this puts Taiwan third in the world, behind France and Belgium, in terms of overall percentage of power generated by nuclear plants. However, throughout much of 1986, Maanshan Unit 1 did not operate. In July 1985, parts of the GE turbine fragmented and caused a plant shut-down. It was not until October 1986 that Taiwan Power Company restarted the plant. A decision has been made for the site of proposed Units 9 and 10, to be located in Yulin County, near Huoan. However, in view of the present uncertainties over nuclear power in Taiwan, this site planning could be premature. In addition to the six operating commercial plants, Taiwan also operates a 40-MWt heavy water-moderated research reactor, the spent fuel from which is to be reprocessed in the USA.

Negotiations for a joint venture agreement between Taiwan Power Company (Taipower) and Rocky Mountain Energy (RME) for an exploration program in the USA were first announced in 1984, and a final agreement was reached in 1986. Unofficial sources indicate that Taipower has agreed to provide funding for uranium exploration over a five-year period. Exploration activities will reportedly involve sites in Texas, Arizona, Nebraska, and Washington; RME's current efforts in the Arizona strip area could receive most of the joint venture's attention.

Until now, much of the uranium for Taiwan's reactors has come from South Africa. Efforts to diversify sources of supply have been frustrated by Taiwan's position with regard to the Nuclear Non-proliferation Treaty. Although Taiwan ratified the treaty in 1970, its subsequent expulsion from the United Nations' group of organizations (including the IAEA), when the People's Republic of China was accredited to the UN, complicated Taiwan's diplomatic position. The only one of the uranium supplier nations that has formal diplomatic relations with Taiwan is the Republic of South Africa. Under a bilateral agreement, however, Taiwan also imports uranium from the USA.

At present, South African-origin uranium destined for Taiwan is imported into the USA for enrichment at DOE. Given the unclear picture concerning the future of such arrangements, because of the law imposing sanctions against South Africa and the related, unresolved questions of import and reexport of uranium, Taiwan's long-term supply from South Africa seems less than secure. A considerable amount of such uranium was reportedly imported into the USA in

1986, to minimize the danger of an immediate ban against reexported material. The postponement in ordering Units 7 and 8, and the fairly large amount of uranium concentrates already in the USA could delay Taiwan's unfilled requirements until the mid-1990s.

In contrast to Japan and South Korea, Taiwan has not attempted to develop a self-sufficiency in nuclear technology. No plans have been announced to develop domestic enrichment or reprocessing capabilities, and no breeder reactor program is foreseen. Enrichment for Taiwan's nuclear plants is carried out at DOE, in the USA, although France's Cogema could supply some enrichment services in the near future.

INDIA

India operates six commercial reactors, having a combined capacity of 1,330 MWe, and has four 235-MWe reactors under construction. An additional four units are in the planning stage. Except for the first two reactors (Tarapur Units 1 and 2), which are General Electric BWRs, India's nuclear base consists almost entirely of pressurized heavy water reactors (PHWRs), which are closely linked by design to its two original CANDU reactors, built in the state of Rajasthan. India also operates a 40-MWt (15-MWe) Fast Breeder Test Reactor at the Kalpakkam complex near Madras, which is being refitted for electricity production. Plans are being made to build a 500-MWe Prototype Fast Breeder Reactor. At present, India operates an extensive domestic nuclear industry, and only relatively few specialized components are imported from abroad.

India's nuclear fuel cycle is based almost entirely on indigenous production. Domestic reserves of uranium are less than 65,000 MTU in all categories. Production comes primarily from the mine and mill at Juduguda, west of Calcutta, and is estimated to total approximately 200,000 pounds U_3O_8 per year. Some additional uranium production comes from recovery operations operated in conjunction with copper mining. At present, except for enriched fuel for the BWRs at Tarapur, India does not import uranium from abroad.

Fabrication of fuel for the PHWRs and the Fast Breeder Test Reactor takes place primarily at the Nuclear Fuel Complex at Hyderabad, in south central India. The complex produces natural UO_2 fuel bundles for the Rajasthan and Madras (RAPS and MAPS) reactors, and enriched uranium fuel assemblies for the Tarapur BWRs. Reprocessing of spent fuel takes place at several facilities in India.

LATIN AMERICA

ARGENTINA

Two nuclear units are in commercial operation in Argentina. Atucha Unit 1 (335-MWe PHWR) and Embalse (600-MWe CANDU). Construction on the country's third unit, Atucha Unit 2 (692-MWe PHWR) is about 60-percent complete and commercial operation is anticipated in late 1988 or early 1989. Argentina's reactor construction company Enace is owned 25-percent by KWU of the FRG, the principal supplier for the Atuchas station. Fuel for the Argentine plants is mined and processed domestically. The country operates a small gaseous diffusion enrichment plant located in the southern mountain region.

BRAZIL

One unit of the three-unit Angra station in Brazil is currently in commercial operation, a 626-MWe PWR built by Westinghouse. The two other units at the Angra site are 1,245-MWe PWRs under contract to be built by KWU of the FRG in cooperation with domestic companies. Construction work is proceeding at a very slow rate due to financing problems. Various German companies share ownership with Nuclebras (Empresas Nucleares Brasileiras SA) in ventures for reactor engineering, heavy component design and construction, uranium exploration, and domestic uranium enrichment.

Brazil has substantial domestic uranium reserves and production of uranium concentrates at its Pocos de Caldas mill exceeded 600,000 pounds U_3O_8 in 1982. In recent years production has been curtailed substantially due to the slow-down of the domestic nuclear power program. Under Bra-

zilian law, domestically produced uranium cannot be sold outside the country. Brazil has developed small conversion capacity and pilot enrichment capacity based on the jet nozzle enrichment process, but most fuel cycle requirements to date have been provided by German companies pending greater development of self-sufficiency.

MEXICO

Construction of Mexico's Laguna Verde Unit 1 (654-MWe BWR) continued during 1986. Laguna Verde is Mexico's first nuclear power plant, located near the city of Vera Cruz on the Gulf of Mexico. The unit is expected to load fuel in June 1987 and enter commercial operation in 1988, however, the Mexican Green party has managed to gather strong last-minute opposition to the operation of the plant, and a series of public hearings are scheduled for 1987. The opposition is primarily based on concerns about safety, caused by the accident at Chernobyl, and the wisdom of using such a capital-intensive technology to produce power in a region of plentiful fossil fuels. A twin unit is currently 50-percent complete, but economic conditions in Mexico have delayed its scheduled completion until the 1990s.

Mexico has several uranium deposits, with reserves sufficient to operate the Laguna Verde reactors for at least 30 years. Commercial development, however, was essentially halted with the onset of Mexico's economic difficulties and the dissolution of URAMEX in 1984. The long-range government policy calls for the development of indigenous uranium supply to meet the needs of the national nuclear program, but current development plans are stalled by the lack of available capital.

SOUTHERN AFRICA

NAMIBIA

Nuexco estimates that Namibian uranium production in 1986 totaled approximately nine million pounds U_3O_8 , about the same as the 1985 level. Rossing, the world's largest open-pit uranium mine, is the sole source of uranium production in Namibia. Nuexco forecasts indicate that Rossing output will remain near the 8 million pounds U_3O_8 per year level for the foreseeable future. Ownership of the Rossing Uranium Limited is listed in Table 32.

In 1985, Rossing's supply contract with the Central Electricity Generating Board (CEGB) in the United Kingdom expired. The last deliveries were made in 1984 and CEGB elected not to renew the contract. However, Rossing has long-standing contracts with utilities in the Far East and Europe. In annual price negotiations concluded in early 1986, seven Japanese utilities and Rossing Uranium Limited agreed on a price of approximately US\$32 per pound U_3O_8 for 1987 deliveries under their long-term contracts. That represented a reduction of about \$1.00 per pound U_3O_8 from the price paid for the previous year's deliveries. Low uranium spot market prices prevalent during the last few years, combined with decreasing energy prices overall, undoubtedly have had a strong impact on annual renegotiations in recent years. The renegotiations for a given year's deliveries are usually concluded in the first quarter of the previous year.

Table 32
OWNERSHIP OF
ROSSING URANIUM LTD.

Company	Country	Percent Share
Rio Tinto Zinc Corp. ¹	UK	41.35
Industrial Development Corp.	South Africa	10.0
Total Compagnie Miniere	France	10.0
Rio Algom Ltd. ¹	Canada	10.0
Urangesellschaft mbH	FRG	5.0
General Mining Corp.	South Africa	6.5
Windhoek government	Namibia	3.5
Undisclosed		13.65

¹RTZ owns 51.3 percent of Rio Algom, so RTZ's net beneficial interest in Rossing is 46.5 percent.

SOUTH AFRICA

Uranium Production

Output from South African uranium producers totaled approximately 12.0 million pounds U_3O_8 in 1986. This represents a decline of about six percent from the 1985 figure. The closure of several mines in 1984 led to a 17-percent decline in 1985 output, but the closure of the Western Deep Levels mine in the second quarter of 1985 had little impact on 1986 production. Harmony Gold Mining Company Ltd. closed its Virginia plant at the end of August 1986 because of declining demand and lower-grade ores. In general, the South African uranium industry has now shut down its unprofitable plants and has curtailed production so that it matches current contract commitments. Table 33 shows a breakdown of uranium production among the ten Chamber of Mines operations that were still producing uranium in 1986. (Beisa, Blyvooruitzicht, and Western Deep Levels are no longer reflected in the table of active Chamber of Mines producers.) In addition, Nuexco estimates that Palabora Mining Company Ltd., which is not a member of the Chamber of Mines, produced 436,000 pounds U_3O_8 in 1986. This figure is a decrease of 9 percent from 1985 production levels. Palabora produces uranium as a by-product of copper mining, and on occasion has stockpiled uranium when revenues from copper have been high.

In September 1986, the Atomic Energy Corporation of South Africa Limited (AEC) released its biennial report on uranium in South Africa. The report, formerly issued under the auspices of NUCOR (Nuclear Development Corporation of South Africa), contained the updated official assessment of the nation's uranium resources and production capabilities. Among other findings, the AEC estimated that as of January 1, 1985, South African resources recoverable at costs less than \$130 per kgU (\$50 per pound U_3O_8), totaled 483,300 metric tons uranium (1,256 billion pounds U_3O_8). This figure represents a five-percent increase from the January 1983 figure. The increase was attributable to extensive exploration in the Witwatersrand Basin, as well as the decline of the dollar relative to the rand, which effectively lowered mining costs in dollar terms so that some resources fell into lower cost categories. In addition, the AEC reported that South Africa supplied 13 percent of the world's uranium in 1985, second only to Canada.

Political Developments

Political and economic developments within South Africa led to wide fluctuations in the value of the rand and the

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outlook for profitable uranium operations. When international banks withdrew credit from South Africa in 1985, the country encountered an economic crisis that led to the imposition of strict financial controls. South African officials immediately attempted to reschedule some \$14 billion of foreign debt, proposing a multi-year rescheduling. Instead, a short-term settlement was reached with 30 major international creditor banks in February 1986, and a similar agreement with several hundred smaller banks was concluded in March. The government and the international banks intend to meet in June 1987 to resolve the issue of the longer-term debt.

The rand responded to the debt agreements, rising steadily in the first quarter of 1986 from the low in early December 1985. However, continued violence and social unrest, including several strikes and incidents of violence at gold and uranium mines, resulted in a reimposition of the state of emergency. That reimposition and the subsequent media attention contributed to another decline in the rand through mid-1986.

While South Africa came under increasing international pressure in 1985 and 1986, the economic and political effects of the most recent and highly publicized sanctions had not yet been felt as of the end of the year. Those sanctions took the form of a bill in the US Congress that had a variety of economic and political ramifications. As the bill gained

support in the House and Senate in the spring and summer of 1986, President Reagan reinforced his policy of "constructive engagement" and his opposition toward any economic sanctions. When presented with the bill in September, he vetoed the measure. Nevertheless, the bill's proponents were able to mobilize the necessary political support, and Congress overrode the veto by a convincing margin. The law became effective January 1, 1987.

Among other things, the law prohibits the import into the USA of uranium ore and oxide. Still at issue is whether the law actually prohibits the import of UF_6 containing South African U_3O_8 , or whether other nations can send South African uranium to the USA for any processing before it is reexported to that nation. Despite that confusion, it is apparent that US utilities will be prohibited from importing South African uranium in any form. However, Nuexco expects that most non-US utilities having South African supply contracts will not unilaterally abrogate or declare *force majeure* against those contracts in the foreseeable future, for several reasons.

1. Any South African uranium already stored in the USA before the law took effect may be exported.
2. US officials may eventually allow the material to be imported for further processing and reexport, or they may grant a grace period to do so.
3. Non-US utilities may adjust delivery shipments and

Table 33

REPUBLIC OF SOUTH AFRICA: 1986 URANIUM PRODUCTION¹ (Thousands of Pounds U_3O_8)

Operation	First Quarter 1986	Second Quarter 1986	Third Quarter 1986	Fourth Quarter 1986	Total 1986
Buffelsfontein	353	300	362	302	1,316
Driefontein Consolidated	41	49	46	43	180
ERGO ²	91	88	79	86	343
Harmony	231	211	171	116	728
Hartebeestfontein	238	264	267	257	1,025
JMS ³	318	305	279	266	1,168
Randfontein	339	324	304	356	1,324
Stilfontein (Chemwes)	137	135	141	226	638
Vaal Reefs	1,082	1,069	1,107	997	4,255
Western Areas	155	147	150	133	585
TOTAL ⁴	2,983	2,892	2,906	2,782	11,563

¹Excludes Palabora Mining Company, which is not a member of the Chamber of Mines.

²ERGO = East Rand Gold and Uranium Company Ltd.

³JMS = Free State Joint Metallurgical Scheme.

⁴Columns may not add due to rounding.

SOUTHERN AFRICA

inventories so that South African uranium is processed at any of the European facilities.

4. Non-US utilities may arrange for swaps or other origin transfers so that South African material is effectively relocated out of the USA.

5. Most South African customers consider South Africa to be a reliable and consistent supplier, and an integral component in long-term uranium supply strategies.

The quantity of South African uranium purchased by US utilities in the past few years has been minimal. Therefore, a liberal interpretation of the law, or one that would allow other nations to process uranium in the USA before export, is not likely to cause any major disruptions in purchases of South African uranium. However, a strict interpretation may not only antagonize foreign customers of DOE and US converters and fabricators, but might also result in some reduced demand for South African material.

Also at issue is whether South African producers will continue to accumulate large stockpiles of uranium. The sales lost as a direct result of the US sanctions will not do serious damage to South African producers. However, if South Africa's other major customers enact similar sanctions, sale opportunities for South African uranium would be severely curtailed. Already, South African uranium is unpopular or banned in many parts of Europe. Thus, South African suppliers may be faced with shrinking markets for their output, and their stockpiled uranium, in the coming years. Because by-product uranium production will continue to be a function of gold production, it appears that the size of the uranium stockpile will continue to increase in the near future.

Specific Comments on Production Operations

Beisa (St. Helena) and Blyvooruitzicht. Both of these mines were closed in 1984, but Blyvooruitzicht continued to produce uranium from its stockpile in order to meet remaining sales commitments. Those commitments were sold to Harmony, and all contracts have now been completed.

Buffelsfontein. Production declined 16 percent because of mining difficulties in the Strathmore shaft area, resulting from the unexpected complexity of the geologic structure. Nevertheless, uranium profits increased due to higher delivery prices and rand prices. The tonnage milled fell by ten percent.

Driefontein Consolidated. Production fell slightly in 1986, as average mill yield decreased. Despite declining grades, this long-life mine is in a strong financial position and is one of the nation's lowest-cost producers.

East Rand Gold and Uranium Co. Ltd. (ERGO). This company operates three divisions for the recovery of gold, uranium and sulphuric acid on the East Rand. Uranium

production remained virtually constant in 1986, but lower grades are forecast.

JMS. (Free State Joint Metallurgical Scheme.) Production fell 12 percent at this mine. While production rates are particularly sensitive to gold prices, this mine is expected to have a long life.

Harmony. With the closure of the Virginia uranium plant in August 1986, Harmony production fell 23 percent. The Virginia plant has been converted for gold recovery. Higher contract prices in 1987 should lead to increased uranium revenues. The tonnage milled in 1986 fell slightly below the record high levels milled in 1985.

Hartebeestfontein. Although the concentrating of mining operations in two shaft areas has led to a lower recovery grade, uranium production rose nine percent, chiefly due to high yields in the second and third quarters of the year. Large ore reserves and the stable financial condition indicate sustained levels of uranium production from this mine.

Randfontein. Production remained virtually constant at this mine, which is moving toward the increased utilization of mechanized mining techniques. The company is engaged in a major expansion through the development of the Doornkop gold mine. The Doornkop shaft is scheduled for commissioning in late 1987, assuring a long life for this operation.

Stilfontein (Chemwes). Production increased by seven percent in 1986, but the mine is moving into its last stages of its life as a gold mine. Uranium production may continue beyond the cessation of gold recovery operations. Stilfontein owns 80 percent of Chemwes, which recovers uranium from surface slimes.

Vaal Reefs. This mine consistently produces about 25 percent of South Africa's uranium, and about 11 percent of the country's gold. Uranium production remained constant in 1986, as tonnages from the entire complex increased. The long-term future of the company will depend upon success in the South Lease area and its extensions. Recent expansion in the South Lease included the construction of 120,000 ton/month plant at the No. 9 shaft.

Western Areas. Despite a greater tonnage milled in the fourth quarter of 1986, production fell 15 percent. Western Areas is highly sensitive to gold prices and costs because it is a relatively low-grade mine. Mechanized mining is expected to account for up to 70 percent of total output by June 1987, and exploitation of newer shafts should allow the mining of deeper, higher-grade sections of the mine.

Western Deep Levels. Uranium production ceased in mid-1985, and the uranium plant has been converted into a 120,000 ton/month gold plant for treating low-grade surface dumps.

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Overview

Judicial and legislative actions affecting the US nuclear power industry during 1986 created greater market uncertainty than at any time since the Three Mile Island accident took place in 1979. While in recent years utilities had been beset with problems of plant cancellations, escalating plant construction costs, regulatory challenges and long regulatory delays, circumstances during 1986 brought the issues of uranium procurement, supply, import limitations, embargoes and enrichment restrictions to the forefront. Many utilities were forced to reconsider their uranium and enrichment procurement strategies when the Federal District Court in Denver, Colorado ruled in favor of a group of US uranium producers and against the Department of Energy. The subsequent appeal, congressional actions, and industry rhetoric from a wide variety of interested parties combined to inhibit

US utilities' purchasing activities and practices. This condition will continue to affect uranium transactions during 1987 and perhaps beyond.

While these external complications slowed buying activity in the USA, and new confidence by the US producer sector pushed producers' asking prices well above current spot-market price levels, the utilities concentrated on plant performance and power ascension for new units. Compared to 1985, results were mixed but encouraging. 1985 was notable for the fact that no units under construction were canceled (an achievement that had last occurred in 1973). During 1986, one unit was officially canceled (Yankee New Hampshire's Seabrook 2), but Philadelphia Electric Company managed to resume work on Limerick Unit 2, a unit that had been suspended. A total of eight units entered commercial operation during 1986 (Table 34). However, several utilities suffered extended shutdowns at plants that had been in operation.

Table 34

US NUCLEAR UNITS' LICENSING PROGRESS DURING 1986¹

Unit	Utility	MWe Net	Type	COD ²
Entered Commercial Operation				
Three Mile Island 1 ³	General Public Utilities	776	PWR	Jan 1986
Palo Verde 1	Arizona Public Service	1221	PWR	Feb 1986
Limerick 1	Philadelphia Electric	1055	BWR	Feb 1986
Diablo Canyon 2	Pacific Gas & Electric	1073	PWR	Mar 1986
Millstone 3	Northeast Utilities	1149	PWR	Apr 1986
River Bend 1	Gulf States Utilities	936	BWR	Jun 1986
Catawba 2	Duke Power Company	1145	PWR	Aug 1986
Palo Verde 2	Arizona Public Service	1221	PWR	Sep 1986
Hope Creek 1	Public Service E & G	1067	BWR	Dec 1986
TOTAL		9,643		
Received Full-Power License				
Shearon Harris	Carolina Power & Light	900	PWR	Feb 1987
Perry 1	Cleveland Electric Illuminating	1205	BWR	May 1987
Received Low-Power or Fuel-Loading Licenses				
Byron 2	Commonwealth Edison	1120	PWR	Jun 1987
Clinton 1	Illinois Power	933	BWR	Jul 1987
Nine Mile Point 2	Niagara Mohawk Power	1080	BWR	Sep 1987
Seabrook 1	Yankee (New Hampshire)	1150	PWR	Indefinite
Braidwood 1	Commonwealth Edison	1120	PWR	Jun 1987
Vogtle 1	Georgia Power	1100	PWR	Jun 1987
TOTAL		6,503		

¹Indicates licensing status as of the end of 1986.

²COD = Commercial Operation Date.

³Three Mile Island Unit 1 reentered the ratebase at the end of 1985, and therefore resumed commercial operation.

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Concurrent with the US producers' initial victory in the federal court regarding DOE policies and utilities' use of US-origin uranium, US uranium production rose substantially during 1986. However, the entire increase was the result of the Umetco/Energy Fuels mill being in operation for the full year processing high-grade ores. While definitive restrictions on the import or enrichment of foreign uranium are likely to benefit US producers, the reduced number of companies still active in the industry exemplifies the weakened condition of the US production sector and implies that any substantial increase in production could be several years away. Those companies that have low-cost operations, most of them through nonconventional sources of production, appear to be the only ones that could survive a continuation of current market conditions.

Nuclear Power Developments

Eight units entered commercial operation in 1986, the same number as in 1985. Eighteen units had been scheduled by the utilities to enter commercial service in 1986, reflecting the degree of optimism still present in plant scheduling. Pacific Gas & Electric Company's Diablo Canyon Unit 2 was one of the units entering service, rapidly following the commercial operation of Unit 1 in 1985 (Figure 21). Duke Power

Company's Catawba Unit 2 entered commercial service in 1986 ahead of schedule, a rare occurrence in the USA. Table 34 shows licensing progress of US nuclear units during 1986. The units entering commercial operation added 9,643 net MWe of capacity to the nation's nuclear generating capacity. At present, over 100 nuclear units are in operation in the USA. Table 34 also shows those plants that received full-power, low-power, and fuel-loading licenses from the Nuclear Regulatory Commission during 1986. Table 35 shows those units, regardless of licensing status, that are scheduled by their utility owners to begin commercial operation in 1987. Nuexco expects that only eight of those units will actually enter commercial service in 1987, adding 8,650 MWe of nuclear-generated electric capacity to the total.

As recently as early 1986, the completion schedules for the remaining thirty-odd units under construction in the USA had been heavily weighted toward 1986 and 1987. Although Nuexco projections indicate that construction and regulatory delays will continue to postpone scheduled commercial operation dates, the bulk of those reactors will be finished and operating over the next five years. In addition, several units currently in the indefinite stage are likely to be officially canceled. Table 36 lists the US nuclear backlog, including 26 plants under either active or suspended construction and two

Table 35

US NUCLEAR UNITS EXPECTED TO ENTER OPERATION IN 1987¹

Unit	Utility	MWe Net	Type	COD ²
Entered Commercial Operation in 1987				
Shearon Harris	Carolina Power and Light	900	PWR	Feb 1987
Scheduled for Commercial Operation				
Fermi 2*	Detroit Edison	1093	BWR	May 1987
Perry 1**	Cleveland Electric	1205	BWR	May 1987
Byron 2*	Commonwealth Edison	1120	PWR	Jun 1987
Vogtle 1*	Georgia Power	1100	PWR	Jun 1987
Braidwood 1*	Commonwealth Edison	1120	PWR	Jun 1987
Clinton 1*	Illinois Power	933	BWR	Jul 1987
Nine Mile Point 2*	Niagara Mohawk	1080	BWR	Sep 1987
South Texas 1	Houston Lighting and Power	1250	PWR	Dec 1987
Beaver Valley 2	Duquesne Light Company	833	PWR	Dec 1987
Palo Verde 3	Arizona Public Service	1221	PWR	late 1987
TOTAL		10,955		

¹Data from published sources and utility estimates.

²COD = Commercial Operation Date.

*Indicates the unit had a low-power license as of the end of 1986.

**Indicates the unit had a full-power license as of the end of 1986.

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units on order. Table 37 lists the commercial nuclear power stations in the USA, and Figure 22 shows their location.

Political Developments

The overriding judicial issue during 1986 arose from the five-count lawsuit filed in December 1984 by three US uranium producers against DOE. The suit alleged that DOE had violated those parts of the Atomic Energy Act of 1954 designed to ensure the viability of the US uranium production industry. The suit, heard in the Federal District Court in Denver, Colorado, began to have outward commercial man-

ifestations as early as September 1985, when District Court Judge Jim Carrigan ruled that the Utility Services Enrichment Contract (USEC) did not conform to the existing criteria governing enrichment, and was therefore promulgated in violation of the Atomic Energy Act. On this basis, Carrigan ruled that the contract was "null and void". The immediate appeal of that ruling forestalled major dislocations in DOE's enrichment program. In June 1986, Carrigan ruled on the remaining four counts of the lawsuit.

The most significant ruling concerned Count I of the lawsuit, which alleged that DOE had violated section 161(v)

Table 36

US NUCLEAR UNITS UNDER CONSTRUCTION AND ON ORDER

Unit	Utility	MWe net	Type	Percent Complete	COD
Fermi 2	Detroit Edison	1093	BWR	100	May 1987
Shoreham	Long Island Lighting	809	BWR	100	indefinite
Perry 1	Cleveland Electric	1205	BWR	100	May 1987
Comanche Peak 1	Texas Utilities	1150	PWR	99	mid-1989
Watts Bar 1	Tennessee Valley Authority	1177	PWR	100	indefinite
Palo Verde 3	Arizona Public Service	1221	PWR	99	late-1987
Clinton 1	Illinois Power	933	BWR	100	Jul 1987
Nine Mile Point 2	Niagara Mohawk	1080	BWR	100	Sep 1987
Seabrook 1	Yankee (New Hampshire)	1150	PWR	100	indefinite
Beaver Valley 2	Duquesne Light Company	833	PWR	98	end-1987
Braidwood 1	Commonwealth Edison	1120	PWR	100	Jun 1987
Vogtle 1	Georgia Power Company	1100	PWR	100	Jun 1987
Watts Bar 2	Tennessee Valley Authority	1177	PWR	86	indefinite
South Texas 1	Houston Lighting and Power	1250	PWR	97	Dec 1987
Bellefonte 1	Tennessee Valley Authority	1213	PWR	85	1994
Byron 2	Commonwealth Edison	1120	PWR	100	Jun 1987
Comanche Peak 2	Texas Utilities	1150	PWR	83	late 1989
WPN 3	Washington PPSS	1240	PWR	75	indefinite
South Texas 2	Houston Lighting and Power	1250	PWR	70	Jun 1989
WPN 1	Washington PPSS	1250	PWR	63	indefinite
Braidwood 2	Commonwealth Edison	1120	PWR	90	Sep 1988
Perry 2	Cleveland Electric	1205	BWR	57	indefinite
Bellefonte 2	Tennessee Valley Authority	1213	PWR	54	1996
Vogtle 2	Georgia Power	1100	PWR	70	Sep 1988
Grand Gulf 2	Mississippi Power & Light	1250	BWR	33	indefinite
Limerick 2	Philadelphia Electric	1055	BWR	50	Oct 1990
Carroll County 1*	Commonwealth Edison	1120	PWR	0	2001
Carroll County 2*	Commonwealth Edison	1120	PWR	0	2002
TOTAL		32,604			

*Indicates unit is on order.

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of the Atomic Energy Act of 1954 (as amended). That section states in part that DOE, "to the extent necessary to assure a viable domestic uranium industry, shall not offer such (enrichment) services for source or special nuclear materials of foreign origin intended for use in a utilization facility within or under jurisdiction of the United States." Because the domestic industry had been deemed nonviable for 1984 and DOE refused to take any action to assure the viability of the industry, Judge Carrigan concurred with the producers' allegation, and imposed an injunction upon DOE to enrich no more than 25 percent of non-US uranium destined for use in US reactors from June 1986 until January 1, 1987; and no non-US uranium could be enriched for US use following January 1, 1987, continuing until the "viability of the US uranium industry is assured." The strength of the order surprised many industry participants, and utility reactions ranged from only slight interest to major concern and threats of further lawsuits and contract abrogations. The most vehement reactions subsided, however, when the Tenth Circuit Court of Appeals granted DOE a stay of the injunction pending appeal.

The appeal was heard in September 1986. During the period from June 1986 through the end of the year, market reactions to the stayed injunction, combined with other events, led to the development of a small premium for US-

origin material. Many US utilities, cautious because of their vulnerability in public utility commission reviews and increasingly unwilling to pay prices over market levels for spot purchases, withdrew from the market for uranium. This was especially true for the discretionary buyers, while those without DOE enrichment contracts were relatively unaffected by origin premiums. Other utilities utilized swap mechanisms and paid premiums of less than \$1.00 per pound U_3O_8 to secure US-origin uranium. Meanwhile, US producers, anticipating the eventual appearance of a significant premium, immediately withdrew all previous offers and began offering uranium in the \$19 to \$20 per pound range for spot and near-term delivery.

While the lawsuit drew the most attention and was the subject of a great deal of speculation, other interrelated political maneuvers influenced strategies and complicated matters for both sellers and buyers.

1. Senator Pete Domenici (R, New Mexico) introduced a comprehensive bill in Congress, covering such issues as uranium usage in the USA, the USEC, the privatization of DOE's enrichment enterprise, the mill tailings reclamation problem, and other items. Perhaps most importantly, the bill determined that for cost recovery purposes the DOE enrichment debt as of FY86 totaled \$350 million, a figure disputed among Congress, DOE, the General Accounting Office and a

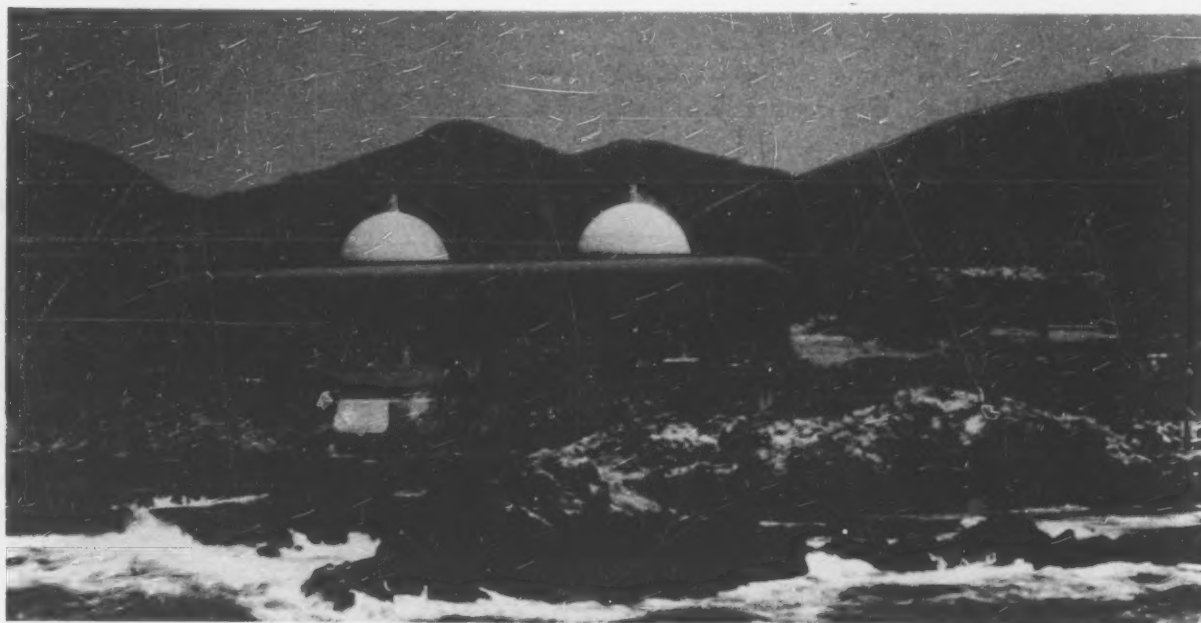


Figure 21. Pacific Gas & Electric Company's Diablo Canyon plant, located near Avila Beach, California. Unit 1 entered commercial operation in May 1985, and Unit 2 began commercial service in March 1986.

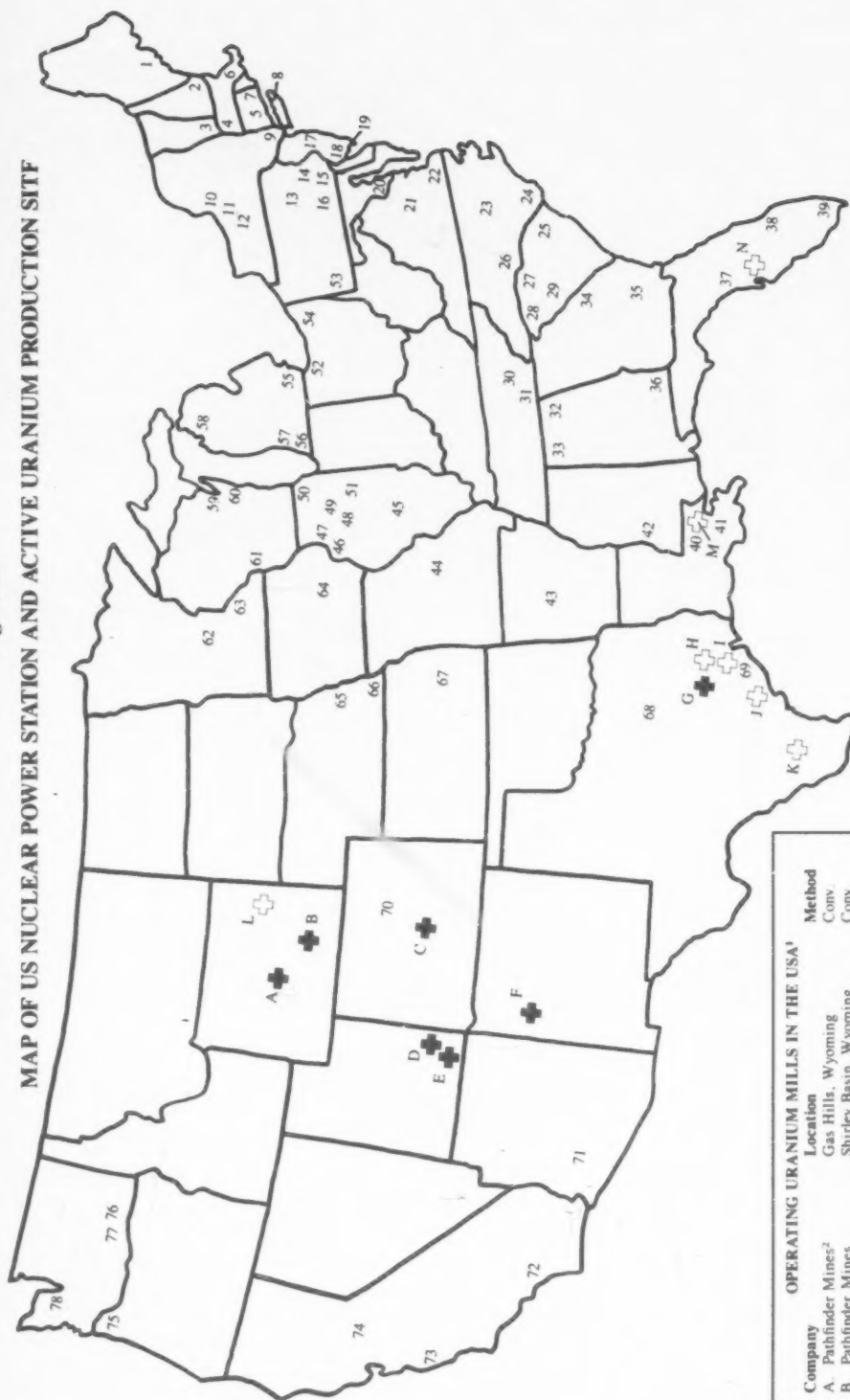
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Table 37
COMMERCIAL NUCLEAR POWER STATIONS IN THE USA

Fuel Buyer	Station	Units	Fuel Buyer	Station	Units
1. Yankee Atomic Group (1)	Maine Yankee	■	42. Middle South Utilities	Grand Gulf	○
2. Yankee Atomic Group (1)	Seabrook	■	43. Middle South Utilities	Arkansas Nuclear	■
3. Yankee Atomic Group (1)	Vermont Yankee	■	44. Union Electric Co.	Callaway	■
4. Yankee Atomic Group (1)	Yankee Rowe	■	45. Illinois Power Co.	Clinton	○
5. Yankee Atomic Group (1)	Haddam Neck	■	46. Commonwealth Edison Co.	Quad Cities	■
6. Boston Edison Co.	Pilgrim	■	47. Commonwealth Edison Co.	Byron	■
7. Northeast Utilities	Millstone	■	48. Commonwealth Edison Co.	La Salle	■
8. Long Island Lighting Co.	Shoreham	■	49. Commonwealth Edison Co.	Dresden	■
9. Consolidated Edison Co. New York	Indian Point 2	■	50. Commonwealth Edison Co.	Zion	■
New York Power Authority	Indian Point 3	○	51. Commonwealth Edison Co.	Braidwood	■
10. New York Power Authority	James A. Fitzpatrick	■	52. CAPCO (2)	Davis-Besse	■
11. Niagara Mohawk Power Corp.	Nine Mile Point	○	53. CAPCO (2)	Beaver Valley	■
12. Rochester Gas and Electric Corp.	Robert E. Ginna	■	54. CAPCO (2)	Perry	○
13. Pennsylvania Power and Light Co.	Susquehanna	■	55. Detroit Edison Co.	Fermi	○
14. Philadelphia Electric Co.	Limerick	○	56. American Electric Power Co.	Cook	■
15. Philadelphia Electric Co.	Peach Bottom	■	57. Consumers Power Co.	Palisades	■
16. GPU Nuclear Corp.	Three Mile Island	■	58. Consumers Power Co.	Big Rock Point	■
17. GPU Nuclear Corp.	Oyster Creek	■	59. Wisconsin Public Service Corp.	Kewaunee	■
18. Public Service Electric and Gas	Salem	■	60. Wisconsin Electric Power Co.	Point Beach	■
19. Public Service Electric and Gas	Hope Creek	○	61. Dairyland Power Cooperative	La Crosse	■
20. Baltimore Gas and Electric Co.	Calvert Cliffs	■	62. Northern States Power Co.	Monticello	■
21. Virginia Electric Power Co.	North Anna	■	63. Northern States Power Co.	Prairie Island	■
22. Virginia Electric Power Co.	Surry	■	64. Iowa Electric Light and Power Co.	Duane Arnold	■
23. Carolina Power and Light Co.	Shearon Harris	■	65. Omaha Public Power District	Fert Calhoun	■
24. Carolina Power and Light Co.	Brunswick	■	66. Nebraska Public Power District	Cooper	■
25. Carolina Power and Light Co.	H.B. Robinson	■	67. Kansas Gas and Electric Co.	Wolf Creek	■
26. Duke Power Co.	William McGuire	■	68. Texas Utilities Electric Co.	Comanche Peak	■
27. Duke Power Co.	Catawba	■	69. Houston Lighting and Power Co.	South Texas Project	■
28. Duke Power Co.	Oconee	■	70. Public Service Co. of Colorado	Fert St. Vrain	■
29. South Carolina Electric and Gas	Summer	■	71. Arizona Public Service Co.	Palo Verde	■
30. Tennessee Valley Authority	Sequoyah	■	72. Southern California Edison Co.	San Onofre	■
31. Tennessee Valley Authority	Watts Bar	■	73. Pacific Gas and Electric Co.	Diablo Canyon	■
32. Tennessee Valley Authority	Bellevue	■	74. Sacramento Municipal Utility District	Rancho Seco	■
33. Tennessee Valley Authority	Browns Ferry	■	75. Portland General Electric Co.	Trojan	■
34. Southern Company Services	Alvin W. Vogtle	■	76. U.S. Department of Energy	Hanford	■
35. Southern Company Services	Edwin I. Hatch	■	77. WPPSS	WNP 1 and 2	■
36. Southern Company Services	Joseph M. Farley	■	78. WPPSS	WNP 3	■
37. Florida Power Corp.	Crystal River	■			
38. Florida Power and Light Co.	St. Lucie	■			
39. Florida Power and Light Co.	Turkey Point	■			
40. Gulf States Utilities Co.	River Bend	■			
41. Middle South Utilities	Waterford	■			

¹Consists of Maine Yankee Atomic Power Company, Vermont Yankee Nuclear Power Corporation, Public Service Company of New Hampshire, Yankee Atomic Electric Company
²CAPCO = Central Area Power Coordinating Group

Figure 22
MAP OF US NUCLEAR POWER STATION AND ACTIVE URANIUM PRODUCTION SITF



LEGEND

In Commercial Operation	Under Licensing or Construction	Shutdown Indefinitely
■	□	■
●	○	●
▲	△	▲

PWR
BWR
Other

Active Uranium Production Sites
 + = Conventional mill
 + = Solution or by-product operation

OPERATING URANIUM MILLS IN THE USA¹

Company	Location	Method
A. Pathfinder Mines ²	Gas Hills, Wyoming	Conv.
B. Pathfinder Mines	Shirley Basin, Wyoming	Conv.
C. Cotter Corp.	Canon City, Colorado	Conv.
D. Rio Algom Corp.	La Sal, Utah	Conv.
E. Uneco/Energy Fuels	Blanding, Utah	Conv.
F. Homestake Mining Co.	Grants, New Mexico	Conv.
G. Chevron Resources Co.	Hobson, Texas	Conv.
H. IEC ³	Three Rivers, Texas	Sol.
I. Everest Minerals Corp.	Live Oak County, Texas	Sol.
J. US Steel/Niagara Mohawk Uranium	George West, Texas	Sol.
K. Mobil Inc.	Bruni, Texas	Sol.
L. Malapai Resources	Powder River Basin, Wyoming	Sol.
M. Freeport Uranium	Donaldsonville and Uncle Sam, Louisiana	By-Product
N. IMC ⁴	New Wales, Florida	By-Product

¹Active during 1986.
²Mill undergoing renovation.
³IEC = Intercontinental Energy Corporation.
⁴IMC = International Minerals and Chemical Corporation.

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variety of special interest groups. The sheer scope of the bill, in trying to solve a wide range of complicated and sensitive issues in one measure, probably contributed most strongly to its demise near the end of the legislative session in autumn 1986.

2. In late 1985, based on an analysis of statistics compiled by the Energy Information Administration (EIA) covering the entire scope of the US uranium mining and milling industry, Secretary of Energy John Herrington determined that the industry was no longer viable in 1984. One year later, the 1986 EIA report concluded that almost all of the short-term indicators of the domestic uranium industry's health were weak, and many were weaker than the previous year's assessment. After reviewing the report, designed to assist him in his determination, Secretary Herrington found that the US industry was also nonviable during 1985.

3. In late 1985, triggered by Secretary Herrington's finding of industry nonviability for 1984, US Trade Representative Clayton Yeutter determined that any action to restrict imports of non-US uranium would adversely affect US trade relations with stable trading partners such as Canada and could lead to retaliatory actions by other nations. Moreover, he concluded that the actual benefit to the US production sector was undemonstrable and probably negligible. This finding was consistent with the Reagan Administration's strong anti-protectionist stand, and served as implicit support in DOE's legal efforts to avoid restrictions on uranium imports.

4. In July 1986, DOE proposed a new set of uranium enrichment criteria to be used as the guidelines under which enrichment services would be performed. The criteria, which contained a number of new provisions, required a 45-day review period in Congress before becoming effective. A number of new provisions in the proposed criteria were controversial, including some obviously designed to support DOE in its appeal of the ruling in the producers' lawsuit. In addition, like the Domenici legislation, the proposed criteria contained a provision for DOE's cost recovery and placed the enrichment debt at \$3.4 billion. While that figure was higher than the \$350 million used in the Domenici bill, the National Taxpayers Union and the government's General Accounting Office asserted that the actual debt is closer to \$7 billion. These controversial issues caused Congress to propose a variety of resolutions designed to disapprove the criteria during the 45-day period. Surprisingly, none were formally adopted. Finally, immediately prior to the end of the 1986 Congressional session, a continuing resolution was passed which *withheld funding* for some of the more controversial provisions of the criteria, including the cost recovery issue. Thus, the entire issue of enrichment criteria remained uncer-

tain through the end of 1986. It is likely that further congressional action will be required on this subject.

Near the end of September 1986, a bill imposing sanctions against South Africa was passed by both houses of Congress and presented to President Reagan for his signature. Reagan vetoed the legislation as expected, but Congress overrode his veto, thereby enacting the Comprehensive Antiapartheid Act of 1986. Among other provisions, the law prohibits the importation of South African uranium ore or oxide. Throughout early 1987, it remained uncertain whether the law, which went into effect on January 1, pertained to South African UF₆, enriched UF₆, or uranium imported into the USA for processing and destined for reexport. The Nuclear Regulatory Commission in December amended its rules to require companies to seek a specific license if they wanted to import South African uranium in any form. Formerly these companies imported material under a general license. The US Treasury Department on March 10, 1987 published a final rule which amends the South African Transaction Regulations and provides essentially that UF₆ is not covered by the sanctions against importation of South African uranium.

The Treasury Department also published an interim rule which provides that uranium in any form may be imported for processing and reexport until July 1, 1987. In the meantime, the Treasury Department will receive written comments on the rule and in the absence of specific legislation rendering the issue moot, will undoubtedly issue a final rule on or before July 1, 1987. Such a final rule presumably will take into consideration comments received, but Nuexco expects the final rule to look much like the interim rule. Certain members of Congress take issue with the Treasury Department's interpretation and may introduce legislation to prevent importation of South African uranium in all forms and for any purpose.

Other Political and Regulatory Actions

Various other political and regulatory actions took place in 1986, focusing on such issues as conversion, waste policy, nuclear accident liability insurance, and financial accounting of construction costs and abandonments. In January 1986, an accident at Sequoyah Fuels' UF₆ conversion facility in Gore, Oklahoma resulted in the death of one worker and a Nuclear Regulatory Commission order to shut down the facility pending an investigation. Several months later, the plant was allowed to receive shipments of U₃O₈ and resume deliveries of UF₆ taken from its stockpile, and in mid-October the NRC authorized the restart of the plant. The restart was contingent upon certain conditions specified in an NRC order modifying

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the license for the plant. The worldwide overcapacity in the conversion market limited any impact the shutdown might have had on secondary market conversion prices and supply.

The protracted developments in finding a suitable site for a long-term high-level nuclear waste repository continued early in the year, as Secretary Herrington announced that the list of nine potential first repository sites had been narrowed to only three. DOE recommended sites in Deaf Smith County, Texas; Yucca Mountain, Nevada; and Hanford, Washington as the primary locations. This announcement immediately set off controversy in each of the locations, and was compounded when Herrington announced that plans for a second repository, to be located in the eastern USA, would be unnecessary. Politicians and observers in the western USA argued that Herrington had succumbed to pressure from eastern influences, and filed lawsuits to reopen the site determination process. Thus, it is doubtful that the US nuclear industry was any closer at the end of 1986 to having firm plans for high-level waste disposal than it was at the beginning of the year.

No progress was made in Congressional attempts to extend the Price Anderson Act, which provides for liability insurance in the event of a nuclear reactor accident. The 1957 Act will expire in August 1987, unless Congress acts on an extension in its 1987 session. While all commercial reactors under license by the NRC at that date will still be covered under the original limits of about \$160 million per reactor, any new units would not be covered under the Act's authority. Thus, liability could be unlimited for any new reactors licensed under those conditions. Moreover, the Chernobyl accident in the USSR caused a reevaluation of issues such as emergency evacuation zones and liabilities, especially the liability limit currently in place. If Congress addresses this issue in the 100th Congress, the limit is almost certain to be raised, probably by a significant amount. Most utilities can be expected to lobby against any substantial increase in the limit, but recognize the inevitability of some increase.

The Financial Accounting Standards Board (FASB), a private-sector body that sets standards for financial accounting in the public sector, in late 1985 released a proposed revision of a statement regarding the accounting treatment of several utility-related projects. The "Statement of Financial Accounting Standard No. 71" addressed the accounting method for plant cost phase-in plans, plant abandonments, and plant cost disallowances. Over 70 organizations and individuals testified at a public hearing in June regarding the statement, and the reaction from the utility sector was largely negative. Opponents of the proposed revision believe that it could cause the financing of nuclear construction projects to become prohibitively expensive. FASB continued to deliberate over the proposed revisions throughout 1986, and are expected to release the final revisions soon.

Production, Exploration and Development

The US uranium production sector, for the first time in five years, recorded a significant increase in production. Nuexco estimates 1986 US uranium production from all sources at approximately 13.8 million pounds U_3O_8 , a 22-percent rise from the 1985 figure of 11.3 million pounds.

Current production sources include conventional mining and milling, by-product recovery, and solution mining. Six conventional mills were in production at least part-time throughout the year compared to five in 1985 (Table 38). In addition, Homestake Mining Company's mill in Grants, New Mexico operated on a limited schedule, processing small tonnages of ore at various times during the year. Production from conventional sources totaled 8.7 million pounds, almost two-thirds of which came from Chevron and Energy Fuels (and its partners).

By-product production, including recovery from phosphoric acid and water from underground mines, totaled slightly over 3.6 million pounds, a small increase from the previous year. For the first time in four years there was no production from oxidized copper ores and from leaching copper waste dumps.

Uranium produced from solution mining totaled about 1.5 million pounds, of which more than 1.4 million pounds was produced in the South Texas district and the remainder in Nebraska and Wyoming. Production from solution mining decreased 650,000 pounds in 1986, all from the South Texas district.

Project Activity

Exploration and development drilling activity did not change significantly in 1986. Nuexco estimates that a total of 1.9 million feet were drilled, up slightly from 1.8 million feet in 1985. Approximately 70 percent consisted of exploration drilling in search of new deposits; development drilling, used to define the extent and grade of ore deposits, accounted for the remainder. Approximately 60 percent of exploration drilling took place in the South Texas district; the remaining 40 percent was evenly split between northern Arizona and all other areas combined. Approximately 60 percent of development drilling was split between South Texas and Wyoming, primarily the Powder River Basin. Of the remaining 40 percent, about 25 percent was confined to northern Arizona and 15 percent to other districts, notably Nebraska.

Important exploration successes were limited to high-grade mineralization discovered in breccia pipes in northern Arizona, and lower-grade ore zones associated with extensions along known mineral trends, primarily in Tertiary sediments of South Texas, Nebraska and Wyoming.

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Table 38
1986 OPERATING STATUS OF CONVENTIONAL
URANIUM MILLS IN THE USA

Company	Approximate Operating Schedule	Rated Capacity ¹	Location
Active Mills			
Chevron Resources Co.	Full	2,500	Hobson, Texas
Cotter Corp.	1/3	1,200	Cañon City, Colorado
Homestake Mining Co.	Partial	3,400	Grants, New Mexico
Pathfinder Mines	1/3	1,800	Shirley Basin, Wyoming
Rio Algom Corp.	Full	750	La Sal, Utah
Umetco/Energy Fuels Nuclear	Full	2,000	Blanding, Utah
Inactive Mills²			
American Nuclear Corp.	Inactive	950	Gas Hills, Wyoming
Anaconda (ARCO)	Inactive	6,000	Grants, New Mexico
Atlas Minerals	Inactive	1,400	Moab, Utah
Bear Creek Uranium	Dismantled	2,000	Powder River Basin, Wyoming
Bokum Resources Corp.	Inactive	2,000	Marquez, New Mexico
Conoco/Pioneer	Dismantled	3,400	Falls City, Texas
Dawn Mining Company	Inactive	450	Ford, Washington
Exxon Minerals Company	Dismantled	3,200	Powder River Basin, Wyoming
Quivera Corp. (Kerr-McGee)	Inactive	7,000	Grants, New Mexico
Minerals Exploration Company	Inactive	3,000	Red Desert, Wyoming
Pathfinder Mines	Under Renovation	2,500	Gas Hills, Wyoming
Petrotomics Company	Dismantled	1,500	Shirley Basin, Wyoming
Plateau Resources Ltd.	Inactive	1,000	Ticaboo, Utah
Sohio Western Mining	Dismantled ³	1,600	Seboyeta, New Mexico
Umetco (Union Carbide)	Inactive	1,300	Uravan, Colorado
Umetco (Union Carbide)	Inactive	1,400	Gas Hills, Wyoming
UNC Resources	Inactive	3,000	Church Rock, Wyoming
Western Nuclear Inc.	Inactive	1,700	Jeffrey City, Wyoming
Western Nuclear Inc.	Inactive	2,000	Wellpinit, Washington

¹Capacity in tons per day

²Mill inactive throughout 1986.

³Began dismantling in September 1986.

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Arizona — In the Arizona strip, the number of companies actively exploring for uranium decreased during 1986. Four major mining companies remain active, but only one or two independent operators are still in the region. Overall, the land position is rather stable; Energy Fuels Nuclear controls about one million acres, Rocky Mountain Energy controls almost 200,000 acres, Pathfinder Mines Corporation controls about 165,000 acres, and perhaps 30,000 to 40,000 acres are under Uranerz Exploration and Mining Limited's control. Energy Fuels is conducting four separate joint ventures for exploration or orebody development throughout the district.

Energy Fuels, in conjunction with its partners, continues production from three mines — the Hack 2, Hack 3 and Pigeon. (Stockpiled ore from these mines presently supplies the White Mesa mill at Blanding, Utah.) The Kanab North deposit is in the late development stage. The shaft was completed to a depth of 1,590 feet, and lateral development into the ore zone from the 1530 foot level is currently underway. At the Pine Nut deposit, shaft sinking began at the end of 1986. Shaft site preparation at the Canyon deposit was curtailed pending resolution of environmental questions. In addition, Energy Fuels is currently evaluating additional pipes with identified mineralization. The active mines as well as the Kanab North and Pine Nut deposits are located north of the Colorado River; the Canyon site represents the only development activity south of the river.

The other three companies are conducting exploration activities throughout their respective land positions, both north and south of the Colorado River. Pathfinder Mines has identified six mineralized pipe structures, five of which are located in the Antelope Valley area of the central Kanab Plateau district, north of the Colorado river. Rocky Mountain Energy and Uranerz have not announced exploration results to date, although both have been active in the district for several years.

Texas — Solution mining methods produced a total of almost 1.5 million pounds U_3O_8 , the lowest amount in the last five years. Six companies reported production, but only Everest Minerals Corporation and the US Steel/NM Uranium joint venture operated at close to a full schedule, together accounting for over one million pounds of the total. The other four companies, in the midst of partial or full restoration programs, produced small quantities. Solution mining projects and the status of each are listed in Table 39.

The only conventional production in Texas took place at the Panna Maria mill at Hobson. Chevron Minerals Corporation, operator of the mill, produced over one million pounds U_3O_8 by processing ore transported from its Mt. Taylor mine, located in the Ambrosia Lake district of New Mexico. No ore was produced by conventional mining in Texas during 1986.

Table 39

SOLUTION MINING PROJECTS IN TEXAS

Project	Status
Chevron Minerals Corporation	Palagana project in full restoration.
Everest Minerals Corporation	Mt. Lucas project in full production; Tex-1 pilot project on standby; Los Palmas in final restoration.
Intercontinental Energy Corporation	Zamzow project in final restoration phase; Lamprecht project entering new production/restoration phase.
Mobil Alternative Energy, Incorporated	Holiday-El Mesquite-O'Hern project in production/restoration phase.
Uranium Resources Incorporated (URI)	Bruni and Benavides projects in final restoration phase.
US Steel Corporation	Burns project in full restoration; US Steel/Niagara Mohawk Uranium, Clay West project in production/restoration phase.

As in 1985, five companies conducted exploration drilling. Again, as in previous years, the primary target was new ore deposits in the Goliad Formation (Pliocene age), which may have the greatest potential for larger and higher-grade deposits, as well as favorable leaching characteristics. The main exploration effort continued along trend extensions through Brooks, Duval, Jim Wells, and Kleberg counties. Exploration for new deposits in the Oakville and Catahoula formations (Miocene age) took place in Live Oak and Bee counties as well, but results were not announced.

Wyoming — The only conventional project that operated throughout the year was Pathfinder's Shirley Basin open-pit mine and acid leach mill. Production from this facility totaled about one-third nominal capacity. The company currently is stripping the overburden from the adjacent property acquired from Petrochemicals in 1985. That ore zone is an extension from Pathfinder's No. 2 Pit, which is essentially mined out. Eventually, waste material from the new pit will be used for backfilling in the No. 2 Pit. The new ore source is expected to add several years to the life of the Shirley Basin operation.

Currently, the only area of interest for solution mining is the South Powder River Basin, where the only sustained production comes from the Bill Smith project operated by Sequoyah Fuels Corporation (a subsidiary of Kerr-McGee Corporation). Everest Minerals Corporation continues to

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evaluate its Highland property (acquired from Exxon in 1984) as it awaits completion of the permitting and licensing process. Plant construction is scheduled to begin in 1987, followed by production in 1988. In August, Malapai Resources initiated a solution mining pilot test on the Willow Creek deposit located on the Christensen Ranch property. Permits for the project allowed testing of sodium and bicarbonate lixiviants at separate sites. The sodium test was completed by the end of the year, and startup of the restoration phase is contingent upon agency approval. The bicarbonate test will begin in early 1987.

Nebraska — Exploration and development in Nebraska consisted of Ferret Exploration Company's activities in Dawes and Box Butte counties. Ferret initiated a solution mine pilot test on the Crow Butte deposit in August, operating at a rate of 100 gallons per minute. Two wellfield patterns are involved, one of which is scheduled to demonstrate restoration procedures in early 1987. The other wellfield may be the basis for later expansion to commercial production. The success of the pilot operation to date indicates the ore deposit is amenable to solution mining techniques. As sole owner of the project, Ferret is structuring a joint venture whereby it will remain as project operator. Joint venture negotiations were in progress as of the end of the year.

Ferret continued to evaluate the Big Red claim group, which covers the trend extension of the Crow Butte deposit. Exploration and fill-in drilling completed in 1986 produced favorable results. The company is optimistic about project potential at this time, and has scheduled additional drilling in 1987.

Utah — Two conventional processing mills operated full time throughout 1986. Rio Algom Corporation's mine and mill at La Sal processed ore from its Lisbon mine, supple-

mented by ore purchased from a few independent mine operators. Rio Algom is scheduled to continue operation through 1987. The Umetco/Energy Fuels mill at White Mesa also operated for the entire year, fed with ore from Energy Fuels' mines in the Arizona Strip. In addition, the company processed ore from independent miners. The mill is scheduled to continue operations through the first four to six months of 1987.

Exploration activity occurred on a limited basis, primarily as required to maintain mining lode claims. Areas of interest included the Lisbon Valley, White Canyon, Cottonwood Wash and Elk Ridge areas. Overall, exploration efforts were directed at possible trend extensions of the large high-grade ore deposits which were mined during the past 30 years.

- **Colorado** — Cotter Corporation operated the Canon City mill at about one-third capacity throughout the year, using ore from the Schwartzwalder mine located near Golden. The ore is trucked to the mill site where it is stockpiled for later milling. Production at the Schwartzwalder mine has been maintained at about 400 short tons per day. However, Cotter announced in January 1987 that uranium production operations would be suspended, pending an improvement in the uranium market.

Exploration and development focused primarily on the south end of the Uruan Mineral Belt in southwestern Colorado, and is an extension of the activity in Utah. In the same vicinity, Umetco, Cotter, and others completed annual claim requirements and maintained some mines on a standby basis. Mine production reached an all-time low, as only one independent miner produced from a deposit in the Salt Wash formation, located on the Utah/Colorado border.

Events that further affected the US uranium industry in 1986 are listed chronologically in Table 40.

Table 40
1986 Uranium-Related Activities in the USA

Month	Organization	Event or Announcement
January	Sequoyah Fuels	Accident at the conversion facility disrupted slurry deliveries from small solution miners. Some projects were forced to curtail operations.
January	Phillips Minerals	Announced it will abandon the Nose Rock mine project, Grants Mineral Belt, New Mexico.
March	Chevron Corporation	Announced mining would continue at Mt. Taylor, Ambrosia Lake district, New Mexico.
March	State of New Mexico	Requested that NRC assume regulatory responsibility for uranium mill tailing sites.
April	Uranium Resources, Inc.	Requested permit to solution mine Kingsville Dome deposit, Kleberg County, Texas.
April	Philadelphia Electric Company	Transferred its 50-percent interest in the Lee mine, Ambrosia Lake district, New Mexico, to Quivira Mining Co., the original owner.
April	Public Service Electric & Gas Company	Terminated 1976 uranium supply contract with Homestake Mining Co.
April	Senator Domenici (R, New Mexico)	Introduced amendment to the Uranium Mill Tailings Reclamation Act of 1985, proposing to reduce uranium imports to 50 percent, establish plan to pay for cleanup of mill tailings, and reorganize the DOE uranium enrichment program. (The bill was not passed in that session of Congress, but could be reintroduced during 1987.)
May	Nuclear Regulatory Commission	Allowed Sequoyah Fuels to start receiving shipments of yellowcake. Small miners began to make slurry shipments.
May	Chevron Resources	Secured a one-year option to purchase the Rhode Ranch deposit, South Texas district.
May	UG USA Inc.	Announced intent to produce byproduct uranium in 1987 at the Bartow, Florida phosphate plant (the uranium plant was purchased from Westinghouse in 1986).
May	Ferret Exploration Company	Purchased Wyoming Fuel Company's 50-percent interest in the Crow Butte project, northwestern Nebraska.
June	US District Court	Ordered DOE to limit amount of foreign uranium it enriched for US utilities to 25 percent of total through 1986, and none thereafter.
June	Nuclear Regulatory Commission	Agreed to assume regulatory authority over New Mexico uranium milling operations.
July	US Department of Energy	Was granted a stay pending appeal of Judge Carrigan's order.
July	Rocky Mountain Energy	Announced signing of a five-year joint venture agreement with Taiwan Power Company for uranium exploration in the USA.
September	Sohio Western Mining	Initiated plan to decommission L-Bar mine and mill, Seboyeta, New Mexico.
September	Uranium Resources, Inc.	Submitted plan to Texas regulatory agencies for solution mining the Rosita deposit, South Texas district.
September	ARCO, et al	Relinquished to US Energy Corp. their mining lease on the APT deposit, Green Mountain district, Wyoming.
October	US Congress	Banned import of uranium ore and concentrates from South Africa.

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Table 40

1986 Uranium-Related Activities in the USA

Month	Organization	Event or Announcement
October	American Nuclear	Sought NRC and Wyoming state approval to move 1.5 million yards of mill tailings from abandoned Riverton, Wyoming site to ANC tailings site in Gas Hills, Wyoming.
October	Altair Resources	Began ground water treatment at the Bison Basin site, Red Desert, Wyoming under contract to the Wyoming Department of Environmental Quality.
October	Sequoyah Fuels	Conversion facility allowed to resume operations, after being closed since January accident.
November	Uranium Resources, Inc.	Received approval from Texas Water Commission to solution mine the Kingsville Dome deposit.
November	Union Carbide Corporation	Agreed to pay \$42 million in reclamation costs at its Uravan, Colorado mill site.
November	Homestake Mining Company	Announced plan to reduce mining rate, Ambrosia Lake, New Mexico to 50 t/d from current rate of about 130 t/d.
December	Energy Fuels Nuclear	Began negotiating to purchase Quivira Mining Corporation, Ambrosia Lake, New Mexico.
December	US Department of Energy	Energy Secretary John Herrington declared US uranium industry nonviable in 1985, for the second consecutive year.



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